Aalto University
School of Arts, Design
and Architecture

Aalto University, P.O. BOX 11000, 00076 AALTO
www.aalto.fi

Master of Arts thesis abstract

Author Aajwanthi Baradwaj

Title of thesis Awareness and participation towards encouraging Sustainable Urban Water Management: A case study of the Jakkur Lake, Bangalore

Department Department of Design

Degree programme Creative Sustainability

Year 2014 **Number of pages** 104 **Language** English

Abstract

This master's thesis investigates how design interventions can enable public participation in the functioning of a sustainable urban water management system, specifically by increasing awareness of the system by involving members of the communities that are linked to it. A unique closed-loop urban water management system — the Jakkur Lake in Bangalore (India) — is utilised as a case study to do so.

The Jakkur Lake is one of the largest and cleanest water bodies in Bangalore and is particularly special because it is a potential model for Integrated Urban Water Management (IUWM). This complex socio-ecological ecosystem highlights the symbiotic relationship between nature and humankind. By serendipity, a sewage treatment plant (STP) with a capacity to treat 10 million litres a day was set up north of the lake by the government bodies. The plant currently releases 8 million litres of treated water into the man-made wetland which further purifies the water by a natural process before letting it enter the lake. Therefore the lake is fed with this treated water everyday, which in turn recharges the ground, increases the water table and fills up the bore-wells and the beautiful old open wells — heritage structures that adorn this area and are in need of preservation. The constant water inflow has helped the lake become a hotspot for biodiversity. It also ensures that the lake is always full, thus providing potable water to people who use the wells around the area. This is what makes the system so special. By this remarkable process, raw sewage is transformed into potable water, and the communities dependent on this water source remain unaware of its origins.

People living and working around the lake impact it through their actions and lifestyles in a variety of ways. For instance, the fishermen community is highly dependent on the lake for their livelihood while some others like the lake activists and members of the sewage treatment plant have a significant role to play in its functioning and sustenance. However, this is a wicked problem where stakeholders understand only their individual roles but not how they are connected to, and impact the larger system.

The study uses ethnographic and design research tools such as interviews, photo-documentation, observation and participatory activities to understand and map out this intricate system. This empirical data is situated within a theoretical framework. A literature review builds background knowledge around the origin and characteristics of wicked problems and gives examples of existing strategies that help cope with these types of problems, as by definition, there is no 'The solution" (Horst, Melvin 1973) for a wicked problem. The framework helps position this particular case within the world of wicked problems and proposes awareness of the functioning system as the first step towards tackling this particular wicked problem, drawing from other strategies that have been written about in the literature.

The study concludes by elaborating on a proposed intervention — an 'experiential' audio-visual walk. This uses the lake as an exhibition walk-through that allows people to experience the space for what it is. A map and an audio guide help the audience in unravelling facts, personal narratives and offbeat aspects of entities around the lake, thus involving the locals, tapping into their knowledge and experiences while increasing awareness in an engaging manner. This is designed for an audience of any age group interested in learning about, or working around this lake, including the decision makers who have a lot of clout. The study ends by discussing feedback obtained from the user testing process, proposes value additions to the walk and provides possibilities of appropriating this model to other lakes around the city.

Keywords Awareness, Complex systems, Multiple Stakeholders, Participation, Socio-ecological systems, Sustainability, Water Management, Wicked problems

Awareness and participation towards encouraging sustainable urban water management

A case study of the Jakkur Lake, Bangalore

Master's Degree programme in Creative Sustainability | 2014
Aalto University School of Arts, Design and Architecture
Aajwanthi Baradwaj

“SOLUTIONS TO PROBLEMS
ARE EASY TO FIND:
THE PROBLEM’S A GREAT
CONTRIBUTION.

WHAT’S TRULY AN ART
IS TO WRING FROM YOUR MIND
A PROBLEM TO FIT
A SOLUTION.”

PIET HEIN

AAJWANTHI BARADWAJ

Master's Thesis

Creative Sustainability | 2014

Aalto University School of Arts, Design and Architecture

Helsinki, Finland

ACKNOWLEDGEMENTS

Working on the thesis has been an exciting and enriching learning process for me. Getting to work in my home country on a topic that I am really interested in was the most exciting part. The process had its own ups and downs like any typical design process and I ended up with what it I have currently – for this, I am very grateful.

I would firstly like to thank S.Vishwanath, my mentor in Bangalore from the environmental architectural firm BIOME and the entire BIOME family for lending me a desk in their office and feeding me with food and ideas whenever I was hungry!
I would also like to thank my Aalto University supervisor, Professor Jack Whalen, without whose guidance my theoretical chapter would be nonexistent and the start and end to this process would not have been as smooth.

A special thanks to all my friends from across the globe for being my constant pillars of support. I am most greatful to my dear parents and family for the faith they had in me, and for all their support to make my studies and life as easy as possible. I am highly grateful to my friends Ambika Kamath, Maitri Dore, and Vinaya Padmanabhan for their expert editing skills and for lending me their voices and ears whenever I needed them. A big thanks to Caroline Knappers for painstakingly proofreading my text.

Last but not the least, to the Creative Sustainability students, teachers and all my friends at Aalto University who have been my family for these past two years in Helsinki.

ABSTRACT

This master's thesis investigates how design interventions can enable public participation in the functioning of a sustainable urban water management system, specifically by increasing awareness of the system by involving members of the communities that are linked to it. A unique closed-loop urban water management system — the Jakkur Lake in Bangalore (India) — is utilised as a case study to do so.

The Jakkur Lake is one of the largest and cleanest water bodies in Bangalore and is particularly special because it is a potential model for Integrated Urban Water Management (IUWM). This complex socio-ecological ecosystem highlights the symbiotic relationship between nature and humankind. By serendipity, a sewage treatment plant (STP) with a capacity to treat 10 million litres a day was set up north of the lake by the government bodies. This plant currently releases 8 million litres of treated water into the man-made wetland, which further purifies the water by a natural process before letting it enter the lake. Therefore the lake is fed with this treated water everyday, which in turn recharges the ground, increases the water table and fills up the bore-wells and the beautiful old open wells — heritage structures that adorn this area and are in need of preservation. The constant water inflow has helped the lake become a hotspot for biodiversity. It also ensures that the lake is always full, thus providing potable water to people who use the wells around the area. This is what makes the system so special. By this remarkable process, raw sewage is transformed into potable water, and the communities dependent on this water source remain unaware of its origins.

People living and working around the lake impact it through their actions and lifestyles in a variety of ways. For instance, the fishermen community is highly dependent on the lake for their livelihood while some others like the lake activists and members of the sewage treatment plant have a significant role to play in its functioning and sustenance. However, this is a wicked problem where the involved stakeholders understand only their individual roles but not how they are connected to, and impact the larger system.

The study uses ethnographic and design research tools such as interviews, photo-documentation, observation and participatory activities to understand and map out this intricate system. This empirical data is situated within a theoretical framework. A literature review builds background knowledge around the origin and characteristics of wicked problems and gives examples of existing strategies that help cope with these types of problems, as by definition, each wicked problem is "essentially unique" (Horst, Melvin 1973). The framework helps position this particular case within the world of wicked problems and proposes awareness of the functioning system as the first step towards tackling this particular wicked problem, drawing from strategies that have been written about in the literature.

The study concludes by elaborating on a proposed intervention — an 'experiential' audio-visual walk. This uses the lake as an exhibition walk-through that allows people to experience the space for what it is. A map and an audio guide help the audience in unravelling facts, personal narratives and offbeat aspects of entities around the lake, thus involving the locals, tapping into their knowledge and experiences while increasing awareness in an engaging manner. This is designed for an audience of any age group interested in learning about, or working around this lake, including the decision makers who have a lot of clout. The study ends by discussing feedback obtained from the user testing process, proposes value additions to the walk and provides possibilities of appropriating this model to other lakes around the city.

KEYWORDS | Awareness, Complex systems, Multiple Stakeholders, Participation, Socio-ecological systems, Sustainability, Water Management, Wicked problems.

CONTENTS

INTRODUCTION

1.1 SUSTAINABILITY AND DESIGN

The biggest challenges our world faces today are linked to sustainability in different spheres. Time and again researchers have talked and written about resource depletion and how there is a big need for awareness, action and behavioural change in order for our planet to sustain itself while providing for the growing numbers of our species. One of the documents that gave birth to the idea of sustainability 'The Limits to Growth' (Meadows, Meadows et al. 1972) states that if the growth in population, industrialization, pollution, food production and resource depletion continue using the current trends as a benchmark, the limits to growth on our planet will be reached within the next hundred years and this might lead to a catastrophic change and disrupt the harmony of our planet. This document has been analysed and revised as the years passed by. In 2012, a review in the international journal 'Nature' expressed concern about approaching "a state shift" or a tipping point in the earth's biosphere (Barnosky, Hadly et al. 2012).

Here is where the combined studies of design and sustainability come into play. The role of a designer is continually being broadened and we, as designers with domain knowledge on sustainability are responsible for understanding and mapping out these complex systems and creating strategies and solutions that help not only deconstruct these systems, but also address issues related to the same. Professors Rittel and Melvin from the University of California, Berkely, have termed such complex issues to be "wicked problems" and have defined ten characteristics of such problems. Out of these, statement number four states, "There is no immediate and no ultimate test of a solution to a wicked problem." And number three states, "The Solutions to wicked problems are not true-or-false, but good-or-bad." (Horst, Melvin 1973). Thus, our task as designers is to plunge into this wicked world to test the 'good' solutions, ones we think have the potential to pull strings in parts of these wicked systems as there is no 'one solution' that would work for such problems. Wicked problems, their characteristics and relevance, along with examples, will be discussed in more detail in the theoretical chapter of this study.

1.2 CONTEXT AND PROBLEM FRAMING

Scouting for a thesis topic along with my interest in the intersection of water, sustainability and communication took me back to Bangalore, where I had studied and worked earlier on related topics.

Bangalore is known as the "City of Lakes" in India. In 1960, there were approximately 282 lakes while today; barely 34 remain in their full glory (Peevee, Lakshmanan 2013). The city has lost more than one lake a year to the growing demands of an increasing human population. Lakes disappear every year due to issues such as encroachment, sewage pollution, and garbage dumping.

This background information led me into researching lakes and water management systems in Bangalore when I stumbled upon videos of the old stone-lined open wells around the Jakkur Lake. They were uploaded by the water expert Vishwanath Srikanthaiah from BIOME Environmental – a Bangalore-based firm focused on ecology, architecture and water. I contacted him regarding my interest to work with this particular lake and he was kind enough to offer to be my mentor for this project. In an interview with S.Vishwanath, he stated that the current key challenge that Bangalore has in terms of sustainability is water management. The main reason is because it has only one reliable source—the Cauvery River that is over 100 kilometers south of the city, and there is a limit to the amount of water that can be drawn from it due to the inter-state political activities and agreements between the state and the farmers. Besides the Cauvery, the only resources that Bangalore can fall back on for fresh water is its groundwater, lakes and wells. As mentioned earlier, even these lakes, wells and other water bodies are fast disappearing and most of them are filled with sewage and garbage.

The system around Jakkur Lake is a unique socio-ecological ecosystem that highlights the symbiotic relationship between nature and humankind. By serendipity, a wastewater treatment plant with a capacity to treat 10 million litres a day was set up north of the lake by the Bangalore Water Supply and Sewerage Board (BWSSB). This treatment plant receives wastewater from about 12,500 households from areas around Jakkur called Yelahanka, Kogilur and Attur layout. The plant currently releases 8 million liters of treated water into the lake every day, feeding the lake, which in turn recharges the ground, increases the water table and fills up the bore wells and the beautiful old open wells – heritage structures that adorn this area and ought to be preserved.

This lake also provides services and livelihood to some of the communities that live around it. There is a family that makes bricks and sells them to contractors, and all the water that is needed for this process comes from the borewell that is fed by the lake. Residents of the village situated near the lake use the lake to wash their clothes, utensils and sometimes themselves. There is a small tank built at the side of the lake to immerse Ganesha idols during Ganesh Chaturti, a Hindu festival where idols of Lord Ganesha are immersed into water bodies. This tank is separated from the lake by a net so that all the debris and flowers can be collected and thrown away before the lake gets polluted. The biggest cohort that is highly dependent on the lake for their livelihood is the fishermen. On a good day, they are able to catch at least 150-200 kilograms of various kinds of fish and during peak season up to 500 kilograms. The fish are fresh and some are still breathing as they are casually tossed out of the net onto the ground, to be measured and sold to the clients who have already lined up for their fresh fish.

Now, with the waste-water treatment plant, the people who work there, the fishermen, the community using the wells around the lake, the birds that flock every morning and evening and the design of the lake itself, there are multiple complex and well functioning systems linked to the same entity- the Jakkur Lake. Every stakeholder is somewhat aware of the various individual functioning parts but are not entirely informed or interested in understanding how the whole system functions. They also do not understand that they have an important role to play within the system. How can a macro level picture of the closed loop system be created? How can the higher authorities be informed about the positive impacts of such a model and made to act upon it, eventually enabling systemic change? Is it possible to take a step forward in creating a more water-sensitive city and how can all the quirky and interesting stories of the individuals and communities around this lake be brought out, to enable awareness and a sense of ownership?

View of the Jakkur Lake from the sewage treatment plant. The foam is created due to the chemicals in the water

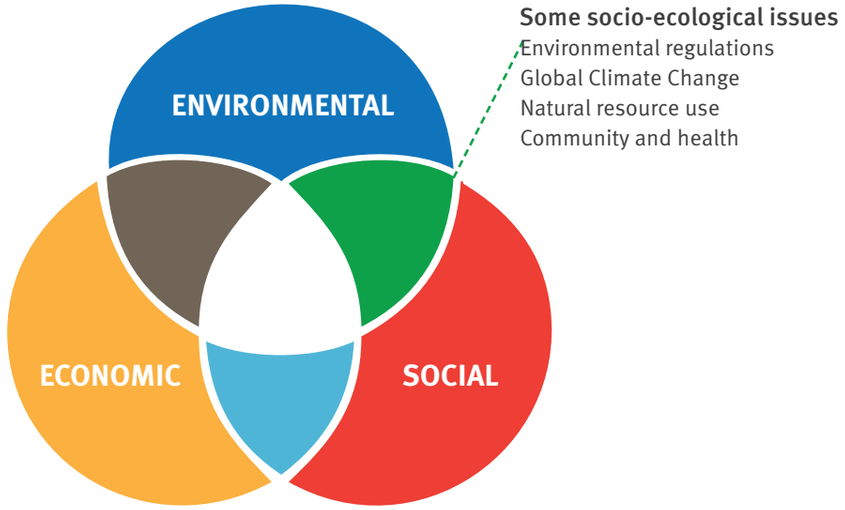
1.3 RESEARCH QUESTIONS

These were the research questions I started off my enquiry with. The insights and results to these will be discussed in the section titled 'Discussion and Conclusions'.

- In complex systems involving multiple stakeholders, how can a designer facilitate awareness and understanding?
- Does more stakeholder involvement necessarily mean better awareness of a particular system and its impacts?
- Can a common understanding of roles and involvement from stakeholders be a catalyst for sustainability?

1.4 PERSONAL MOTIVATION

The area of socio-ecological sustainability, specifically zooming into the world of water has always been a fascination for me, right from my bachelor studies. My bachelor thesis was focused around creating a toolkit of participatory activities to build awareness around water and sanitation in rural India. There is a lot of information and communication around water being the most precious resource for mankind, yet the problems around it only seem to be widening just like any other. The sustainability education at Aalto University fuelled this interest and gave me a new box of tools I could approach such complex problems with. Systems thinking, design for social change and strategies to address wicked problems are theories and frameworks that helped me look at these substantial issues via realistic lenses to propose interventions that would have a ripple effect, affecting various parts of the given system. These interventions will not necessarily 'solve' the wicked problem of urban water management but gives the designer in me a "one-shot operation" (Horst, Melvin 1973) to test out a solution that might have a significant impact on the system that is being dealt with.



THEORETICAL FRAMEWORK

Issues related to sustainability often involve dealing with complex systems. The social, ecological and economic factors, amongst many more, are constantly affecting each other, creating dynamism and resulting in the interaction of multiple stakeholders, who naturally have varied interests and goals. Therefore, understanding and addressing such constantly evolving systems becomes challenging (McPhearson 2013).

Literature from urban planning defines such problems as 'wicked' and their characteristics have been identified and written about by Horst Rittel and Melvin Webber. This chapter begins by exploring what a 'wicked problem' is, defines its characteristics and provides examples related to the case, to illustrate them in parallel. It then moves on to discuss literature that presents various strategies that have been identified and employed to address such wicked problems. Most of the current literature is based in the field of policy, planning and governance but various other fields including design, are beginning to recognise similar patterns within the systems they are dealing with.

Systems thinking, a concept from the ecological and social sciences is another body of knowledge that is highly linked to wicked problems and sustainability. A small portion of this review also touches upon how wicked problems, systems thinking and sustainability are linked to each other, and how these theories can be applied while dealing with complex human-based systems in the real world.

This framework suggested for planners is evaluated in the context of wicked problems in water sustainability, focusing on the case of the Jakkur Lake. The chapter ends by positioning the intervention proposed in the thesis case as a possible first step to understanding the system holistically, while pulling strings at various parts of the system, before moving to employ other strategies proposed in the literature.

2.1 WHAT ARE WICKED PROBLEMS?

The idea behind a 'wicked problem' is not very new. Professor Horst Rittel from the University of California, Berkely, first coined the term in the Seventies, to characterise social problems related to planning. In the paper he co-authored titled 'Dilemmas in a General Theory of Planning', he compares and contrasts the relatively easy challenges that planning had to deal with until the late 19th century such as paving streets, building sewage and water lines and providing housing, to the more complex problems such as location of a freeway, adjustment of tax rate and other such governing systems in the 20th century. He states that planning problems are "inherently wicked". He also talks about "tame" problems, the opposite of wicked, which present a clear problem to solve and a route to follow, of the sort that engineers and mathematicians typically deal with. These tame problems are relatively clear and straightforward to solve, i.e. a mathematics formula or a move in a chess game where one uses equations or makes a move on the board. An example in contrast to this is a problem related to social policy and planning, where any factor is linked to every other node within the system. Thus a single move would affect the system at various unexpected levels (Rayner 2006, Horst, Melvin 1973). These are the kinds of problems where the traditional linear methods of problem solving are inadequate and thus require new methods and strategies.

Further, classifications of the types of problems also exist. Nancy Roberts (Roberts 2000), for example, pinpoints three types of problems. Type I problems or "simple problems" are ones that can be solved using the traditional expertise and linear process i.e. fixing a broken machine. Once the engineers know that something is wrong, they use their expertise to recognise what the problem is, and fix it. There is one 'right' answer and process is straightforward.

Type II problems are "complex" problems. These are problems in which the problem solvers are able to agree upon the definition of the problem but not on the methodologies or solutions (Roberts 2000). For example, there is water shortage in an apartment. Everyone agrees that this is a problem but when it comes to proposing a solution, some might want to install a rainwater-harvesting tank while others might want to dig a bore well into the ground. Despite a common understanding of the problem's definition, this still remains a complex problem to solve due to the conflict that arises between the various stakeholders.

Type III problems are the "wicked problems". These are ones where unlike the type II problems, there is no common consensus on the understanding of the problem itself. This only increases the amount of conflict between all the stakeholders (Roberts 2000). The issues around Jakkur would be a good example to illustrate this type of problem. There is a lake around which communities live in informal settlements, as there is no affordable housing elsewhere. They do not have access to piped water supply and hence depend on the lake and open wells in that area for their daily water needs. They have no choice but to wash their clothes in the lake using detergent, thus polluting the lake. The land surrounding the lake belongs to the government and the pressure to 'develop' the area results in them filling up the southern wetland to build affordable housing for people with low income. What could we say is 'the problem' here? Is it the lack of a water supply or lack of affordable housing? Is it the lack of knowledge about urban water resources or bad planning of urban spaces? Attempts to solve 'the problem' will only result in chaos. In a democratic society, there might be more complications that arise due to stakeholders as they are allowed to block solutions that are not in their interest, using lawsuits and judicial reviews (Roberts 2000). No factors help frame this large problem and solving this problem thus becomes a highly complicated and challenging task.

TYPE I SIMPLE PROBLEMS

Clear problem definition

Traditional and linear problem solving process

TYPE II COMPLEX PROBLEMS

Clear agreement on problem definition

No clear methodologies

TYPE III WICKED PROBLEMS

No clear problem definition

2.2 CHARACTERISTICS OF WICKED PROBLEMS

Wicked problems are not just complex problems, and they have been named so not because there is anything ethically wrong with them. The term 'wicked' is only used in the sense of a problem being vicious or difficult to deal with (Horst, Melvin 1973). Rittel and Webber (Horst, Melvin 1973) describe a set of ten characteristics that need to be grappled with, if these special problems are to be addressed. Discussed below are the characteristics they have identified.

1. One cannot understand a wicked problem without attempting to solve it

"The formulation of a wicked problem is the problem!" (Horst, Melvin 1973) Typically, framing any problem within a single solution or "panacea" in mind, as (Ostrom, Janssen et al. 2007), assumes that it is possible for us to understand a problem very accurately and compactly. Often problems are also categorised into specific disciplines in the very first step, highly limiting the possibilities of solutions and of understanding the issue holistically i.e. If water management is formulated to be a ecological problem, the solutions have already been limited to ones that are based within this bracket, as solutions are very closely linked to the process of problem formulation. This situation would only cause disagreements amongst other stakeholders who will not be in agreement with the proposed solution due to their varied interests and goals. Hence, such problems always need to be addressed using a systemic approach and the solutions that are proposed only help expose new aspects of the problem and not necessarily 'solve' anything in its complete sense. Rittel and Webber sum this up by saying, "One cannot understand the problem without knowing about its context; one cannot meaningfully search for information without the orientation of a solution concept; one cannot first understand, then solve" (Horst, Melvin 1973). Problem definition and solution finding are processes that go hand in hand.

2. There is no clear stopping point when solving a wicked problem

Since clause number one states there is never 'The Problem' or 'The Solution', there are no criteria that can inform us when this back-and-forth process of problem definition and solution identification can be stopped. Unlike a mathematical equation when the solver knows that he/she has obtained the right answer, planning and designing problems have no such endpoint. There are no ends to solving issues within "interacting open systems" and any solution that is proposed can always be made "better". (Horst, Melvin 1973)

According to Rittel and Webber, a planner terminates a process not due to the logic of the problem but only due to the lack of resources such as money, time, energy or patience. The planner finally says, "That's good enough," or "I like this solution" or "This is the best I can do within the limits of this project," etc.

In the context of design and water, or urban water management, the same can be applied. If one is trying to 'solve' the issue of urban water management, that can be termed an unrealistic task as one is dealing with engineers, funders from the government, many civic bodies, the various local communities, and the natural habitat, to name a few stakeholders. Any solution that is proposed is not going to be the ultimate solution that helps solve the issue of sustainable water use. A realistic method would be to understand the system, choose a particular lens and test a solution within that, to see how it is received. It is important to note the kind of impact or ripple effect the solution creates in the other linked spheres within the system. Hence, a project like this needs to be piloted, stopped and reformulated at a time when these larger effects are spotted, or when the designer has run out of a particular resource—time, money etc.

3. Solutions to wicked problems are not true-or-false but good-or-bad

There are no prescribed rules to help evaluate if a solution is 'correct' or 'false' when it comes to addressing a wicked problem. In social contexts like these, usually, "many parties are equally equipped, interested, and/or entitled to judge [them]," and these judgments are obviously based on individual stakeholder interests, values and goals. Therefore, a given solution can only be termed "good", "good enough", "bad" or "satisfying" and such. (Horst, Melvin 1973)

In the context of water, a proposed solution might really appeal to the end users, if they are promised their fair share of water, but the same might not be well received by the government officials who have to invest in the infrastructure for the same. Hence, we can only conclude that a proposed solution can be good or bad and this is also highly dependent on the lens one is using to look through.

4. There is no immediate or ultimate test of a solution to a wicked problem

With tame problems, there is a way to spot how the solution was arrived at i.e. the steps to solving a mathematical equation are very clear and straightforward and is also fully under the control of the individual or few people involved

in the process. When it comes to a wicked problem, any proposed solution will affect various other parts of the system and these repercussions may only be seen or tracked over time. They might appear at an unexpected place or time and might be either positive or negative. Thus, a perfectly well intended solution could affect the system in a way that makes the planner feel that the system was better off, before the solution was implemented. To study the full consequence of a solution would mean tracking all its effects and all the affected lives, and this cannot be done within a limited time span (Horst, Melvin 1973).

Another small example from around Jakkur can be used to illustrate this point. There was a bore well dug near the Jakkur Lake to tap into the groundwater and cater to the water needs of communities living in that area. An unexpected incident led to this land being sold to a private owner, automatically making the well his own. Water from this well was drawn and sold to private companies in tankers, depleting the groundwater that is public property while also depriving the local community of their water. These events took place until a case was filed against the landowner (Srikantaiah 2013). Now, this well is being used by the families who live in informal settlements on that piece of land. Such are the turns solutions can take when one is dealing with wicked problems.

5. Every solution to a wicked problem is a "one-shot operation". Learning by trial–and-error is not an option in such situations

As concluded from the previous criteria, every solution to a wicked problem has consequences and leaves "traces" that cannot be undone. As Rittel says, "One cannot build a freeway to see how it works and then easily correct it after unsatisfactory performance." This is the paradox the planners have to deal with. One cannot understand the problem without proposing solutions but every solution proposed might have unintended repercussions which might even just add to the existing dilemma instead of solving or addressing parts of it (Horst, Melvin 1973).

Drawing from the same example stated in the previous point regarding privatization of water, the consequences of the dug up well are not something that can be undone even if it were possible to cover up the well and make it unusable now. Such are the solutions to wicked problems. One gets only "One-shot" (Horst, Melvin 1973) at implementing it and it either turns out right or wrong.

6. Wicked problems have innumerable possible solutions

There are no criteria that will help prove that all possible solutions to a wicked problem have been identified or considered. In this world of "ill-defined problems", one can only try out possible solutions – sometimes there might be none at all! (Horst, Melvin 1973)

Issues around urban water access and management could be addressed in numerous ways – it could be done at the policy level, by involving the citizens and local communities, by recycling water, by reducing water usage and waste and the list just goes on.

7. Every wicked problem is essentially unique

There are no two problems that will have identical characteristics, thus making every problem we examine, unique in its own trivial sense. When it comes to wicked problems, Rittel and Webber use "essentially unique" as they state that there would be that one distinguishing property that overrides all other similarities between the two problems that are being compared. "Part of the art of dealing with wicked problems is the art of not knowing too early which solution to apply." (Horst, Melvin 1973)

When it comes to the social context, we are often dealing with dynamic systems where so many factors need to be considered. No one solution would fit any two wicked problems. Thus, such systems have to be individually understood and designed for. "Over time one acquires wisdom and experience about the approach to wicked problems, but one is always a beginner in the specifics of a new wicked problem." (Conklin 2010)

8. Every wicked problem can be considered a symptom of another problem

The need for urban water management could be a symptom of water usage patterns, which is a problem that arises due to bad urban planning or over population, and this arises due to the lack of education, and so on. Every wicked problem arises and leads to another wicked problem.

9. Discrepancies in representing a wicked problem can be explained in many ways and this explanation determines the nature of the problem.

Continuing with the previous example, industrialization could be used as a factor to explain water scarcity and this could be attributed to rise in individual greed, consumption patterns, advertising etc. There are numerous ways to explain this one wicked problem and the route we take determines its nature and the solutions we propose.

10. Those who have the power to research and address wicked problems have no right to be wrong

In the world of planning and wicked problems, there is no forgiveness if actions lead to unexpected errors. The aim with these types of problems is not to find the ultimate truth but to improve certain characteristics of systems that benefit the world at large. People who work in this space are liable to the solutions they propose as they can affect the lives of people they are designing for in an immense way.

Rittel and Webber's ten characteristics have some repetitions and redundancies. Researchers like Steve Rayner and Jeff Conklin have condensed the same characteristics into six, essentially identical in terms of content.

These characteristics are more "descriptive than definitional" (Conklin 2010). Especially when it comes to issues related to sustainability, it is essential to not get caught in determining how 'wicked' a problem is, and instead look at what contributes to, or causes this wickedness and address that part-by-part. The solution being proposed would entirely depend on the lens one chooses to work with, as Rittel's first statement describes. A few examples of such wicked problems in the word of sustainability and the environment would be climate change, water management, energy production and biodiversity loss.

2.3 COPING WITH WICKED PROBLEMS

This study will focus on examples related to water and water management, as that is the wicked problem being dealt with. As explained in parallel with Rittel and Webber's characteristics framework, it is an established fact that water management is a wicked problem. Once this has been acknowledged, the next step would involve looking at how one could cope with this wicked problem. As the literature indicates, there is no one particular formula that can be applied across wicked problems as each one is "essentially unique" (Horst, Melvin 1973), but broad strategies that help cope with such problems have been presented.

2.3.1 COPING STRATEGIES | CATEGORIES

It has been established that a traditional and linear process of identifying a problem, gathering information, analysing this information and then coming up with a solution that would be implemented, is not the strategy that works with wicked problems (Roberts 2000). The coping strategies must be non-linear, taking into consideration the various interacting systems, while allowing one to understand and solve the problem simultaneously.

The existing literature suggests approaching wicked problems via large strategies. On this point, Nancy Roberts (Roberts 2000) argues for three strategies within which solutions to wicked problems might lie. Interestingly, she uses power distribution amongst stakeholders as the main criterion both while categorising as well as deciding which strategy to adopt. The three strategies she proposes are authoritative, competitive, and collaborative. She puts forward certain criteria regarding the power distribution within a system to help decide which strategy to employ. Within a particular system, if the power lies with one person or a small group of stakeholders, Roberts suggests that the authoritative strategy be used. If the power is dispersed and the stakeholders contest power, then the competitive strategy is suggested. If the power is dispersed but there is no struggle or competition for it, then the collaborative strategy is suggested.

AUTHORITATIVE STRATEGIES

An authoritative strategy effectively aims to minimise the number of stakeholders involved in the decision making process, thus automatically reducing the wickedness of a problem. "Authoritative strategies are 'taming

strategies.' They diminish the level of conflict inherent in wicked problems by putting problem solving into the hands of a few stakeholders who have the authority to define a problem and come up with a solution" (Roberts 2000). The advantage of this strategy lies in reducing the complexity and the amount resources involved in the decision making process while on the other hand, the disadvantage is that the solutions or choices might be poorly informed and cause more harm than good to the system.

COMPETITIVE STRATEGIES

As the name suggests these strategies involve a competition and thus, a win-lose situation. The involved parties compete against each other to solve problems. On one hand, this strategy might enrich the ideation process and promote efficiency, as the competitors need to get ahead of each other. On the other though, if pushed to its extreme, it could lead to chaos or violence, depending on the nature of the problem that is being dealt with.

COLLABORATIVE STRATEGIES

Collaborative strategies are based on the premise that stakeholders "can accomplish more as a collective than they can achieve by acting as independent agents" (Roberts 2000). Unlike the previous win-lose situation, collaboration proposes a "win-win" situation. Hence, it is important that all the stakeholders agree to solve the problem together, keeping all their individual interests in mind. The advantages of collaborative strategies would be the distribution of costs, sharing of benefits, and prevention of redundant efforts. The disadvantages would lie in the fact that the stakeholders need to meet often to make decisions together. This would require time, space, funds, facilities and effort. In this case, it is important to make sure that the benefits of collaboration outweigh the resources that are utilised during the process (Roberts 2000).

2.3.2 COPING STRATEGIES | CRITERIA

While Roberts equips us with large categories within which strategies that help us deal with wicked problems can be placed, authors Mason and Mitroff write about a more zoomed-in perspective. They define certain practical criteria that need to be taken into account while addressing a wicked problem. They argue that when it comes to designing for the real world, the solution-finding process must involve four criteria – participation, adversity, integration and support of the managerial mind (Mason, Mitroff 2010).

Participation: when dealing with wicked problems, the pool of knowledge to be dealt with comes from various stakeholders. The implementation of the solution would also necessarily require support and resources from these stakeholders. Thus, the nature of the problem dictates active participation.

Adversity: "Doubt is the best guarantor." (Mason, Mitroff 2010)
Mason and Mitroff argue that the assumptions and biases that exist within each stakeholder need to put forward, for an effective judgement.

Integration: while participation and adversity bring in the various thoughts, ideas and assumptions, it is important to not get lost within them but instead, integrate them into creating a concrete plan that could guide the problem solving process.

Support of the managerial mind: the important task of understanding the complexity and developing a "world view" (Mason, Mitroff 2010) of the problem lies in the hands of managerial staff and policy makers, and thus, in such cases, it is essential to back them up with sufficient support systems.

If we try to look for similarities between the authors' views, both Competitive and Collaborative strategies have a high chance of containing Mason and Mistroff's criteria but it is unlikely that the Authoritative strategies would involve much participation and adversity, if only one person or a small group of people have the power to make decisions.

2.3.3 STUDYING AND TAMING WICKED PROBLEMS

The two last strategies that will be discussed in this section are the ones proposed by Professor Jeff Conklin. As Rittel and Webber stated in (Horst, Melvin 1973), not all problems are wicked. In contrast are the tame problems, ones for which the traditional and linear process can help yield workable solutions within a particular time frame. Jeff Conklin in his book 'Dialogue Mapping: Building Shared Understanding of Wicked Problems' writes about two organisational coping mechanisms that can be applied to wicked problems: "studying the problem and taming it."(Conklin 2010)

Conklin suggests that the first step in coping with a wicked problem is to "recognize its nature." The usual tendency is to look at any problem as tame: perhaps because they are easier to solve, or because of the lack of understanding in the dynamics of a wicked problem and the tools required to cope with them. The two coping mechanisms he suggests are: to study the problem and then to tame it.

While studying a given problem is a natural process, if one is dealing with a wicked problem, this could turn into an infuriating task. The normal process of data gathering and analysis will only provide us with little information about a wicked problem. Therefore, study only leads to more study that leads to a condition called 'analysis paralysis,' "a Catch 22 in which we can't take action until we have more information, but we can't get more information until someone takes action". Wicked problems require persistence, doing experiments, making decisions, creating and testing prototypes and a repeat of any of this if necessary (Conklin 2010).

The second strategy of taming a wicked problem is the most natural and common way of handling a wicked problem. Instead of dealing with the whole wickedness of it, one simplifies it and deals with smaller parts. Conklin (Conklin 2010) puts forward six criteria than help tame a wicked problem, in line with Rittel and Webber's criteria that define them.

1. Lock down the problem definition
To choose one focus or definition for the problem that is being dealt with and move forward.

2. Assert that the problem is solved
To ensure that there is some authority or force that is making sure that the problem is being solved.

3. Specify objective parameters by which to measure the solution's success
Only when a solution is measured does it become concrete, and amounts to having solved it.

4. Cast the problem as 'just like' a previous problem that has been solved
Identify similar problems that have been dealt with earlier (benchmarking) and follow a similar problem solving process.

5. Give up on trying to get a good solution to the problem
Do the best you can and maybe the solutions can be revised later

6. Declare that there are just a few possible solutions, and focus on selecting from those options.

Conklin ends this section of his book with a warning that even though taming a problem might seem tempting given a short amount of time, it fails in the larger picture. He predicts that the wicked problem would simply reassert itself in the same or different form, or worse, the tame solution might only make the problem larger.

2.4 WICKED PROBLEMS AND SYSTEMS THINKING

"Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static 'snapshots'...Today systems thinking is needed more than ever because we are becoming overwhelmed by complexity" (Senge 1990).

Now that complex systems in social planning have been discussed in the previous subsection, it is essential to take a step back and look into 'Systems thinking'. This body of knowledge originated in the 1920s, much before wicked problems did, notably in biology and engineering. Systems thinking is a way of organizing and understanding a complex world (McPhearson 2013). Its essence lies in looking at inter-relationships rather than linear cause-and-effect chains, and in studying processes of change rather than snapshots (Senge 1990). This statement shows us that unlike wicked problems where humans and human interactions play a big role both in creating, as well as addressing complexity, systems theory is examining something much larger. It is about looking at larger-than-life systems and studying patters within them to help us understand and address complexity at that scale. Systems thinking is moving away from the current reductionist mode of problem solving, the idea that "objects, phenomena, explanations, and theories can be reduced to their individual parts to understand the wider system" (Veale 2013). Instead, it is based on the idea that no component within a system exists in isolation. Each component is only a small part of a larger system of interacting networks such as: social networks, ecological networks, political networks, economic networks and so on. Drawing from this, Systems Theory states that it is inadequate to understand the parts of a system to predict the behavior of the entire system (McPhearson 2013). The importance of each component is linked to its relationship to the whole, and thus the properties of the system are properties of the whole (Neill 2007). Therefore it is essential for us to study the whole system, understand the patterns within it, examine the mistakes that have been made in the past, and then develop new strategies that help the unstable system reach a stable state. Here, it is interesting to look at what Holling (C.S.Holling 2004) has to say about 'transformation' within systems. Holling describes the process of change within a system as being complex and difficult to plunge into. He states that complex systems go through cycles

of change that are organized within the forward and backward loops. During these loops, the system creates vulnerability, and presents opportunities for reorganisation. He states that these back-loops might lead to opportunities for transformation of the system, and if utilised effectively, the system could reach a positive new state. If the transformation fails to happen, chaos would have to be dealt with. He also stresses that these points of high instability are when individuals can actually step in and make a difference. "During such times, uncertainty is high, control is weakened and confused, and unpredictability is great. At the same time, space is created for reorganization and innovation. It is therefore also a time when individual cells, individual organisms, or individual people have the greatest chance to influence events. In societies, there is opportunity for exploratory experiment if the experiments are designed to have low costs of failure" (C.S.Holling 2004).

Systems thinking uses analytical models, graphs and computer generated data to analyse systems. During the 1950s, when the natural process of a body of knowledge breaking into disciplines took place, Systems Analysis was born. The task of a systems analyst or engineer was to find out how to reach a desired state in a system, when the objective of the system was a given. Methodologies that required "naming of the system and defining of its objectives", in which the engineer or analyst tried to intervene to make the system reach a desired state, were termed 'Hard Systems' methodologies (Checkland 1981) With due course in time, there was an increasing realization that in 'human activity systems', the system could not be 'named' convincingly and the objectives of these systems were often tough to define as they were multiple in number, and often conflicting. This led to the development of Soft Systems methodology (SSM). SSM was born for reasons similar to Rittel's – the need for new strategies to address a set of complex problems that could not be addressed using the traditional methods that the scientists and mathematicians employed (Shankaran, Leigh et al. 2008) The pioneer of SSM, Peter Checkland, along with his associates from Lancaster University felt that the methodologies proposed for hard systems were not suitable to tackle 'ill-structured problems' in the real world, as they were ones for which a clear end-state could not be agreed upon. Thus, they concluded that 'human activity' based systems need to be termed as 'soft systems' as opposed to 'hard systems'. While hard systems methodologies focus on tangible outcomes, SSM focuses on clarification of the problem, identifying weaknesses and understanding relationships and complexity. In his paper on SSM (Checkland 1981) discusses the seven-step methodology to follow while addressing these ill structured problems, i.e. wicked problems.

- Entering the problem situation.
- Expressing the problem situation.
- Formulating root definitions of relevant systems.
- Building Conceptual Models of Human Activity Systems.
- Comparing the models with the real world.
- Defining changes that are desirable and feasible.
- Taking action to improve the problem situation.

Checkland states that the linearity in these steps was only to make the process easy to understand and teach, as it was developed specifically to teach people how to address real world conflicts and situations. Even though this is a step-by-step model, the processes are very iterative and thus there is a lot of back-and-forth that will take place when applying them to any situation. Similar to Rittel's view that solving wicked problems requires multiple perspectives from the stakeholders, Checkland via SSM, also encourages understanding and debate amongst the stakeholders as a strategy to reach a common definition that makes the functions and purpose of the system clearer (Shankaran, Leigh et al. 2008)

2.5 SUMMARY AND REFLECTION

In this section, I have briefly discussed literature that define wicked problems, and the various methods and strategies that researchers have adopted in order to cope with them. The advantages and disadvantages of each strategy have also been weighed. The section ends by linking this literature to systems thinking theory, stressing on the relevance and advantages of using this while dealing with wicked problems.

The examples discussed in this chapter, along with other large wicked problems such as climate change, loss in biodiversity, resource depletion, urban planning etc., all link back to sustainability in some way, and are issues that design can play a big role in addressing. Identifying whether or not a problem is wicked becomes an easy task using the characteristics defined by Rittel and Webber. The trick lies in not getting lost in its 'wickedness', but in studying the system to create a common understanding of the causes of its complexity. Once a problem is identified as wicked, the strategy one adopts to deal with it entirely depends on the nature of the problem, the number of stakeholders that are involved, as well as the kind of resources available to the designer.

Issues related to sustainability invariably involve working within a social context. This means that we, as designers, are often dealing with dynamic systems where numerous factors need to be considered. As discussed earlier in this chapter, no 'one' solution would fit any two given wicked problems, but strategies can be employed to aid the solution-finding process. One aspect that can be stated and agreed upon is the need to understand each individual system holistically, before designing for it. In the end, this will create learning that might or might not be entirely applicable to other contexts, but components from this learning could be appropriated to address other similar systems. As Conklin rightly sums up, "Over time one acquires wisdom and experience about the approach to wicked problems, but one is always a beginner in the specifics of a new wicked problem" (Conklin 2010).

Unlike the other strategies discussed in this chapter, systems thinking contrasts, and offers a holistic paradigm to understand complexity using "cognitive tools supportive of sense making, including, systems-mapping, mental models, systems dynamics, iterative process of inquiry and other intuitive approaches. Systems-thinking helps designers find the places of intervention in wicked problems" (Veale 2013).

SSM, a subsect of the systems thinking theory that is discussed above is of particular interest as it is a framework that goes hand-in-hand while working with wicked problems that involve 'societal systems' or 'human activity systems' as Rittel and Checkland would respectively call them. SSM was specifically developed to help address real-world problems that involve complexity and human activity, by taming them to a certain extent. Thus, it is important to look into these methodologies, as most systems that designers tend to work with within the social sphere would typically fall into the category of problems that do not have a formal problem definition. In such situations, as both Conklin and Checkland state, it is important to first study the problem to formulate "a root definition" or a common understanding of what the system comprises of. This thinking that is echoed by both Rittel and Checkland has recently been re-rightly examined as a 'problem definition' is itself subjective and originates from a stakeholder's point of view – "Therefore all stakeholders' points of view are equally knowledgeable (or unknowledgeable) whether they are experts, designers or other actors" (Fuad-Luke 2009) . Thus, even if a problem definition is agreed upon, we have to keep in mind that it might not be a very accurate or a neutral one, but this is definitely the best possible first step, without which no proposed ideas would function or be accepted. There would be no dialogue and no common agreement on how to frame the problem, goals or actions (Fuad-Luke 2009) . Once this common understanding has been reached, there could be various strategies applied to try and addressed some of these identified problems. It is also very essential to involve all the stakeholders in order to reach this common understanding as the entire process of analysing a system or addressing issues within it would otherwise be redundant.

As social designers, systems we try to work with are often in a chaotic and vulnerable state, and Holling claims that any effort to create transformation within a system is most effective when it is in this particular state. Here, it is essential to keep in mind that smaller parts of the chaos need not necessarily add up to the whole, and therefore this presents a bigger need to first understand the system holistically, along with the various components within it, before attempting to transform the system in any grand way.

While being a beginner in dealing with a new wicked problem, a key word to recollect from the theory is 'cope'. Even though it sounds disappointing, it must be accepted that one can only cope with wicked problems, but on the brighter side, every step forward in coping with such problems, still remains a large victory in the long run. Even though SSM breaks the process down and makes it applicable to everyday problems, both going through the individual steps and ideating to find the right interventions still remain challenging tasks.

As a designer, applying parts of this framework to the system around the Jakkur Lake helped me recognise the need to understand the various small factors that affected the system, as well as the system as a whole. It also informed me about how important a first step it was, to make the involved stakeholders understand the same. Naturally, this was not an easy task and it required many conversations and interventions. For me, this process automatically broadened the scope of what designers could do while addressing complex systems like these. Here,

Professor Alaister Fuad-Luke's definition of a design activist as a person who is able to use design for the "greater good of humankind and nature. A person who is a free agent; a non-aligned social broker and catalyst; a facilitator; an author; a creator; a co-author; a co-creator; and a happener (someone who makes things happen)." (Fuad-Luke 2009) comes into play. The more I delved into the system, the more I recognised the need for a "non-aligned social broker and catalyst." The role that was taken up by me in this project was of a design activist, where the system being dealt with was in a vulnerable state, and the chances of creating an understanding or impact was large.

The Jakkur Lake case study is a good example of what systems theory tries to explain. In this case, research suggested that each stakeholder understood his/her individual role, but this did not necessarily lead to an understanding of the interconnections within the system or the functionality of the entire system. This caused conflicts in the sustenance of the water resource and its surroundings.

> *People who live in this informal settlement near the lake drink water from the open well that is part of their land area*

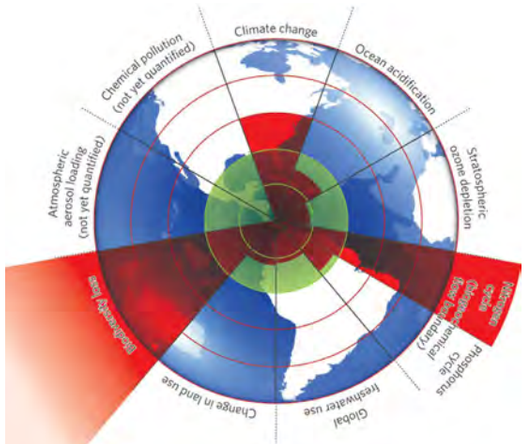
I would place the intervention proposed as part of this case within Conklin's strategy of 'studying' a wicked problem and testing out ideas and prototypes. To avoid getting caught in an 'analysis paralysis', it is essential to know when to stop studying and start acting upon something. The first three steps of the seven-step methodology in SSM also suggest the same course of action. The experiential walk proposed as part of this study is a step that nudges stakeholders to act upon the issues they feel the need to work with, using strategies they are equipped with – the decision makers possibly using authoritative strategies, other private sewage treatment plants or organisations using competitive strategies or the local communities and lake activist groups using collaborative strategies. This intervention helps them understand the system and its various components, encouraging them to look into aspects that each one connects with, or feels the need to address. My role as a designer was to unearth the stories that around this system and make them available to everyone. Keeping the collected stories and information unbiased, and open to interpretation were other factors that I realised were important. Creating this map, or a possibility of a common understanding was a first step towards analysing the wicked problem as well as designing strategies to cope with it. The experiential walk around the Jakkur Lake created this kind understanding amongst the stakeholders. This mainly occurred due to information sharing that took place between the various stakeholders during the walk. The next chapter will explain the case study in detail, concluding with how this solution was arrived at.

CASE STUDY

This section explains the premise within which the case study lies. It begins with the global water crisis and then zooms into India – specifically Bangalore, to explain why there is a need to re-think water management at the city-level. Managing urban water has already been established as a wicked problem in the theoretical section. This chapter discusses strategies that could help in managing water, specifically in Bangalore city. The last and largest strategy leads the reader to the next section that discusses the model around Jakkur Lake, and how this can be understood and replicated for effective water management at the city-level.

3.1 CONTEXT: WHY WATER, INDIA AND BANGALORE?

Our anthropogenic pressure on the earth and its resources has reached a state that is testing the limits of our planet. Researchers from across the globe have collaborated with the Stockholm Resilience Center to produce a diagram of the 'Planetary Boundaries' – the non-negotiable earth system processes that we need to address to avoid catastrophic tipping points and enable sustainable development in our world. All these planetary boundaries are inter-related and a variation in one might affect another adversely, hence systems thinking comes into play at the largest perceivable scale. If we were to look at global water use and management, we humans have a big role to play in it as we are responsible for the various changes and manipulations caused in the freshwater cycles, river flows etc. Water directly affects health, agriculture, biodiversity and the ecological functioning of the living species (Rockström, Will et al. 2009). When it comes to the 'Global Freshwater Use', the fact that we still remain within the green 'safe' planetary zone gives us some hope of envisioning better ways to manage this vital resource before it is too late. "There is a water crisis today. But the crisis is not about having too little water to satisfy our needs. It is a crisis of managing water so badly that billions of people - and the environment - suffer badly," says the World Water Vision Report (World Water Council)



Estimates of how the different control variables for the planetary boundaries have changed from 1950 to present. The green areas represent the safe operating space.
Source: J. Lokrantz/Azote | http://www.stockholmresilience.org

The mismanagement of water is a social and environmental ill that is most prevalent in urban areas. Mass urbanization is bringing in a cohort of migrants into the cities and currently, this trend is common across the globe. There is an increasing demand for all natural resources in urban centres, water being one of the most predominant. In India, a projected 220 million people are expected to move into urban slums in the next 20 years and along with this comes a huge increase in demand for all resources, including one of the most vital for survival — water (Bhushan, Gupta et al. 2013). Along with this, other global change pressures, increasing costs and poorly planned and maintained urban water management systems are causing cities to face great difficulties when it comes to managing scarcer and less reliable water sources.

Bangalore is India's third largest metropolitan city and is one of the fastest growing economic zones in South Asia. Currently a home to over 9.5 million inhabitants, this number only rapidly increasing due to immigrants who move to the city to find better jobs, Bangalore is struggling to keep up with the increasing demands of its growing population (Sharma 2013). An ironic fact is that Bangalore has the costliest water in India, even though it was known as the 'City of Lakes'. In 1960, there were approximately 282 lakes while today, barely 34 remain in their full glory (Peevee, Lakshmanan 2013). The city has lost more than one lake a year to the growing demands of the human population.

During an interview, water expert S.Vishwanath stated that the current key challenge that Bangalore has in terms of sustainability is water management. The main reason is because Bangalore has only one reliable water-source—the Cauvery River that is over 100 kilometers south of the city. There is a limit to the amount of water that can be drawn from the Cauvery due to the inter-state political activities, and agreements between the state and the farmers. "We can draw only about 1400 million liters per day and it has to come all the way from 300 feet below the city and 100 kilometres away. There are projects that have already been implemented for this", Vishwanath stated. This is one of the reasons Bangalore has the costliest water in India (Srikantaiah 2013). Besides the Cauvery, the only resources that Bangalore can fall back on for fresh water are its lakes and ever-sought-after groundwater. As mentioned earlier, even these lakes, wells and other water bodies are fast disappearing and most of them are filled with sewage and garbage.

"THE CURRENT KEY CHALLENGE THAT BANGALORE HAS IN TERMS OF SUSTAINABILITY IS WATER MANAGEMENT"

S.VISHWANATH

The depletion and contamination of groundwater is only worsening the situation. Building borewells is a common way of dealing with water-shortage but this is not helping, as the groundwater levels are too low. Studies have shown that underground aquifers are inadequate in the rocks of the city. There are already about 172,000 borewells in the city and 300 of them run dry every month (Basu 2013). Due to the high stress on this resource, the government recognized the problem and passed a new rule, making it mandatory for all existing borewell owners as well as those drilling new borewells or open wells, both for domestic and commercial purposes, to pay a fee and register in a prescribed format. The government hopes that this would reduce the number of illegal borewells in the city. Currently, the mining department's study shows the total recharge of groundwater from various sources is about 90 million liters per day (MLD) as compared to a withdrawal of 341 MLD. In other words, groundwater is overdrawn by an astounding 378 per cent (Basu 2013).
According to the statistics of the city's lifeline, Bangalore Water and Sewerage Board (BWSSB), the per capita water supply that they are able to provide the city averages between 100 to 125 liters. However, the actual availability of water to some of the poor areas of the city can be as low as 40 to 45 liters per day due to infrastructural or availability constraints. The per capita national standard for a city the size of Bangalore is about 200 liters per capita per day (LPCD). Globally as well, a city with an average population of 10 million or above is allocated 200 LPCD. Bangalore is currently at a population of 9.6 million (Census of India. 2011). This means that the city needs at least 1800 MLD, whereas it has only 1400 MLD from the Cauvery, even out of which there is a loss due to wastage during transport (Basu 2013).

So, from these statistics, it can be seen that the city is already slipping below the 200 LPCD standard. Many question this standard and argue that greater efficiency can be achieved in consumption patterns, but keeping in mind the current standards, the city is suffering to meet its demand. The big question is: how is this deficit being met? Where is the rest of the water coming from? "It is all groundwater," said S.Vishwanath, when asked about how the city meets its demands. Given the current situation, how then does Bangalore manage one of its wickedest problems – its growing need for water?

3.2 MANAGING WATER AT THE URBAN SCALE

This section discusses certain strategies that could be employed to manage the demand for groundwater in Bangalore city. The last strategy written about is the one that is currently being practiced at the Jakkur Lake. This leads the reader to the next section, which explains this particular strategy in detail and discusses why this is a good model to promote urban water sustainability.

What are some ways to manage the demand for groundwater in a city like Bangalore?

A. Reducing demand and increasing efficiency

One obvious way to bridge the supply-demand gap is by curbing the usage of water. This might be achieved by multiple ways, some of them being behavioral change in water usage patterns, capturing rainwater, spreading awareness and introducing appliances that are water efficient, and thus help reduce consumption (Hassell 2007). These would then be efforts that help push the LPCD from 200 to 100 or below but on the other hand, it has been noted that the richer layouts in Bangalore actually consume over 250 LPCD. Even when the pricing was increased, the numbers did not drop. "A lot of this water was used for landscaping as people liked to have some greenery around them, and this is not really factored into a city's water plan. There is a huge increase in water demand due to this," said S.Vishwanath. Hence, one way to manage the growing need for water is to look at ways to reduce the demand and get efficient with its usage.

B. Recycling water

A second method to bridge this gap can be by recycling water. "Now, if 1400 MLD of water comes into the city there is about 1100 MLD that will go out as wastewater. What we do with all the wastewater, is a big challenge," says S Vishwanath. The city and government realise that this is an issue and have been trying to do their part at the policy level. There are plenty of initiatives and laws that encourage and enforce recycling and rainwater harvesting at the apartment level. An example would be the Bangalore Water Supply and Sewerage (Amendment) Bill 2011, making it mandatory for citizens who propose to construct on site areas that are not less than 1200 square feet to install rainwater harvesting systems in their area for storage of rainwater or recharge of groundwater (Rainwater harvesting Bill passed in Assembly 2011)

Bangalore has the largest number of wastewater recycling units in India because it is mandatory for apartments or non-commercial establishments that have more than 50 units or consume more than 50,000 litres of water, to have their own wastewater treatment plant, according to the Karnataka State Pollution Control Board's (KSPCB) amendment passed in the year 2010. This recycled water is then used for flushing and other non-potable activities like washing of cars and watering of gardens. Hence, this is a small vision for treating water at the household or apartment level and using the treated water within the homes.

There is a bigger vision for wastewater treatment within the city where water is treated in primary, secondary and tertiary sewage treatment plants for industrial use. Yelahanka, an area in north Bangalore has a tertiary treatment plant that recycles 10 MLD and transports it to the international airport and other factories where the recycled water is used for production.

C. Lakes and STPs partner to form a closed-loop system

If we move away from our anthropocentric view to recognize the role of our ecological system and utilize its symbiotic processes, a third vision can be argued for. "If we do not wish away water as something that only moves in pipes for human use but also look at it as something that moves within the larger ecosystem, we could envision recycling it in other ways," says S.Vishwanath. Eventually the water could return fit for human use, but it is benefiting to give nature a chance to act upon its resources. It is more efficient than we humans are, and allows us to capture its treatment capacity. This is the third route, and this is what is happening at the Jakkur Lake currently.

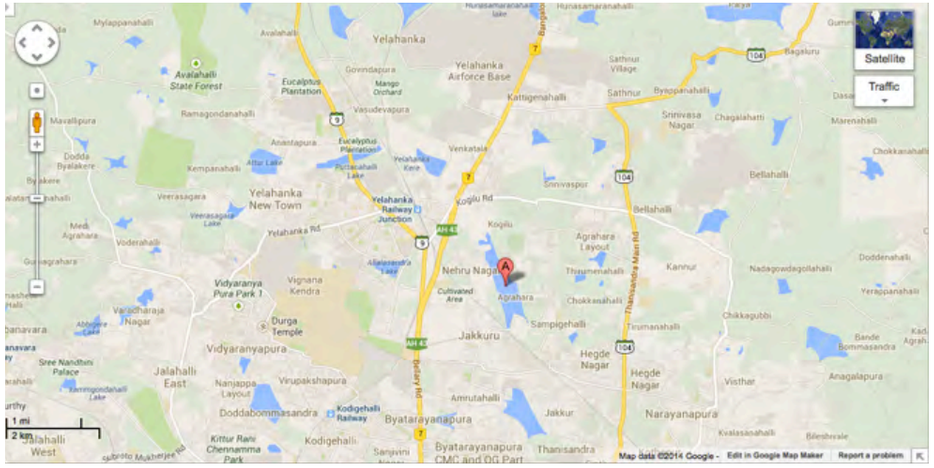
3.3 WHAT MAKES THE JAKKUR LAKE SO SPECIAL?

Lakes and other water bodies, as ecosystems are very important, especially in an urban context. In cities like Bangalore that are privileged to have abundant lakes and open wells, ground water recharging could help enormously with the ever-evident water crisis. These lakes act as aquifers – harvesting rain, collecting excess water and bringing up the water table. In a "water sensitive city" (Brown, Keath et al. 2008), it is essential that all the roles of water – the cultural, social, economical, spiritual and economical are addressed, and this is happening to a large extent at the Jakkur Lake. It is a vision of what a city could do with its water, on its way towards creating a "water sensitive city".

The Jakkur Lake is in the north-eastern part of the city and is one of the largest [140 acres] and cleanest water bodies in Bangalore. It is the main lake in the chain of lakes comprising of the Yelahanka Lake upstream and the Rachenahalli Lake downstream.

In 2003, the Bangalore Water Supply and Sewage Board (BWSSB), a civic body in the city had set up a 10 MLD Upflow Anaerobic Sludge Blanket Digestion (UASB) sewage treatment plant in the area of Jakkur.

The drain that carries the treated water from the sewage treatment plant into the wetland and the lake — after the water has been tested for its quality



Top: *Location of Bangalore in India*
Bottom: *Location of the Jakkur Lake in Bangalore with the Yelahanka lake upstream and Rachenahalli lake downstream*
Source: *Google Maps*

The citizens and public interest litigation groups had been pressurising the government to do something about the lakes in the city, as most of them are polluted with sewage, garbage or being encroached upon. One such event resulted in the Jakkur Lake being rejuvenated by the Bangalore Development Authority (BDA). It was fenced and de-silted. Islands were created for birds and trees were planted on the sides of the lake. It was serendipity that all this activity was taking place just downstream of the Jakkur Sewage Plant. As part of the design of the lake, they incorporated a man-made wetland at the northern tip of the lake to help the biodiversity thrive. The wetland acts as a natural filter, improving the quality of water in the lake.

Besides being a freshwater lake that provides water to the city, the Jakkur Lake is particularly special because it is a potential model for Integrated Urban Water Management. This unique socio-ecological ecosystem highlights the symbiotic relationship between nature and humankind. The STP that was built at the north of the lake has a capacity to treat 10 million litres a day. This treatment plant receives wastewater from about 12,500 households from areas around Jakkur like Yelahanka and Attur Layout. The plant currently releases 8 million litres of treated water into the man-made wetland, which further purifies the water by a natural process before letting it enter the lake. Therefore the lake is fed with 8 million litres of treated water everyday, which in turn recharges the ground, increases the water table and fills up the bore-wells and old open wells around this area. The architecture of the massive open wells near the lake is noticeable, as it is made without any cement or lime. Each day, 100,000 liters of water is drawn from the biggest step well near the lake, to be used for agricultural purposes. The farmers state that the well gets recharged and returns back to its original state within a day, due to the lake (Srikantaiah 2014).

The constant water inflow has helped the lake become a hotspot for biodiversity of all kinds. It also ensures that the lake is always full, thus providing potable water to the communities who use the wells around the area and this loop is what makes the system so special. In an interview with S.Vishwanath, he stated that as of now, Jakkur provides potable water that comes from the ground for about 100,000. If one lake can provide water for about 1 hundred thousand people, it would only be sensational to imagine all the lakes of Bangalore performing the same way. This model would be preserving the ecosystem and providing millions of people with potable water, while recycling all the wastewater generated by the city at the same time. This would be the third and largest water-vision for the city.

Along with the above stated benefits the lake also provides services and livelihood opportunities. As mentioned earlier and can be seen in the table, there are various stakeholders involved in this system. There is a family that lives by the lakeside and makes bricks for a living. All the water that is needed for this process comes from the bore-well that is fed by the lake. People from settlements nearby use the lake to have a bath as well as wash their clothes and utensils. Cultural artifacts such as the small tank built for Ganesha immersion during the festival of Ganesh Chaturty, in a well thought out manner, is separated from the lake by a net, so that debris and flowers can be collected before the same pollutes the lake.

Top: *A view of the Jakkur Lake from its northern tip*

Right: *A table showcasing all the identified stakeholders in this case*
Key for the table: *Government/Civic bodies that have power and leverage in the policy and decision making processes.*

Communities that impact the water body directly with their usage patterns and other actions

Citizens interested in protecting certain aspects of the water body/people who lobby for the betterment of the water body

ACTOR/STAKEHOLDER	ACTIVITY (W.R.T THE JAKKUR LAKE)
STATE GOVERNMENT	POLICY MAKERS / Make decisions regarding the functioning and maintenance of the water bodies in the city
BWSSB (Bangalore Water and Sewerage Board)	SEWAGE TREATMENT PLANT / In charge of all the water and sewage related activities in Bangalore city including the Jakkur STP
PRIVATE COMPANY (In contract with BWSSB)	IN CHARGE OF THE STP / Employees are hired to make sure the sewage is treated, the treated water tested, and let out into the lake. They also ensure that the treatment plant functions as per set standards
BDA (Bangalore Development Authority)	WETLAND / In charge of making sure all the flora and fauna in the wetland area are well maintained for it to perform its functions in the best possible way
FISHERIES DEPARTMENT	FISH IN THE LAKE / Seeding and making sure there is enough fish in the lake to provide a source of income for all the fishermen while maintaining an ecological balance
GROUNDWATER DEPARTMENT	GROUNDWATER, WELLS / Checking and maintaining recharge rates both of the groundwater as well as the wells around the lake
FISHERMEN	PEOPLE WHO FISH IN THE LAKE / They depend on the lake for their livelihood by fishing and selling the fish to their customers
END USERS	People who have access to the lake and its surroundings for personal use : Washing, Walking, Drawing water from wells etc.
BIRD WATCHING ENTHUSIASTS	COME TO WATCH BIRDS / Hobbyists who mobilise groups to visit the lake area
LAKE REVIVAL GROUPS	Take up and deal with any issues that need to be addressed w.r.t lakes and help maintain lakes in the city

The biggest cohort that is highly dependent on the lake for their livelihood is the fishermen community. On a normal day, they are able to collect at least 100 kilograms of various kinds of fish and during peak season up to 500 kilograms. The fish are fresh and some are still breathing as they are casually tossed out of the net onto the ground, to be measured and sold to clients who have already lined up for their share.

With the lake under the BDA, the STP under the BWSSB and the pollution control board, the fish under the fisheries board, the communities using the wells, the fishermen, the birds that flock every morning, and the design of the lake itself, there are multiple complex yet well functioning systems linked to the same entity—the Jakkur Lake. Every stakeholder, including the big decision makers are partially aware of the various individual parts of the system but are not entirely informed or interested in how it functions at a macro level. There are many factors that are responsible for the above situation. In a system that involves multiple stakeholders, it is only a given that there are differences in interests and goals. Stakeholders have their individual tasks to perform in order to make ends meet, and in this particular case, research suggests that this has been done in a satisfactory manner. The STP employees ensure that the quality of water follows the set standards, as it exists the plant, the fishermen ensure that their customers do not go empty handed and the local villagers ensure that their families have clean clothes and utensils to use, by washing them in the lake. Another factor to keep in mind is the power or leverage that each stakeholder possesses for creation of change. As the above table suggests, the government and civic bodies are the ones with most power when it comes to policy level changes and decision-making. Often, this is the level at which issues need to be addressed to create large-scale impact. The communities that interact with the lake on a daily basis impact the lake directly due to their usage patterns and other actions, but do not have much power or inclination to affect the system otherwise. Changes in behaviour, activities and views are some possibilities if these communities are interested in creating small-scale impact. Lastly, there are also a group of citizens who are interested in protecting certain aspects of the water body – ones who lobby for the betterment of the lake. This body has a big role to play in the politics of the city, as they are the ones responsible for carrying issues to the court. Some of these cases eventually lead up to some action from the government's side. Having said all this, a major drawback that was observed was a lack of communication amongst all the stakeholders. The importance and interconnectedness of the various involved actors was not recognised or acknowledged.

How can a macro-level picture of this closed-loop system be created and bought to notice? How can the key institutions and higher authorities be informed about the positive impacts, and potential of such a model? How can all the interesting stories of the individuals and communities around this lake be brought out? These goals cannot materialise without public involvement and participation.

ROLES OF A LAKE IN AN URBAN SETTING
"A good water management plan would mean and include the many roles of water such as the spiritual, the cultural, the ecological and the recreational." S.Vishwanath

***Environmental:** Acts as an aquifer, provides potable water and attracts biodiversity (flora and fauna)*
***Economic:** Provides livelihood opportunities (fish are sold)*
***Spiritual:** A small temple is built by the side of the lake*
***Cultural/Spiritual:** A tank for immersion of idols of Ganesha (the elephant God), after a festival called Ganesh Chaturty is built by the side to prevent the Jakkur lake from getting polluted*
Social: Women come in groups to wash clothes and utensils in the lake

As seen in the map below, the STP owned by BWSSB is at the north of the lake. The western side is currently entirely covered with agricultural land but there is a dispute between the government and the farmers and a case been filed for that land. On the eastern side and down south there are residential complexes that are currently being built. Downstream of Jakkur, there is a new housing layout called the Arkavati Layout that the BBMP has been developing for the past 10 years. This plot is soon going to be filled with apartments and houses and is a major threat to the lake. These buildings need to have their own STP to make sure that the wastewater is regulated

A MAP OF THE JAKKUR LAKE SHOWING THE MAIN (CIVIC) BODIES THAT ARE INVOLVED

- *BDA: Bangalore Development Authority*
- *Private Property*
- *BWSSB: Bangalore Water and Sewerage Board*
- *BBMP Property: Bruhat Bengaluru Mahanagara Palike*
- *Railway Line*

3.4 PROCESS

This section will introduce the reader to the various ethnographic and design research tools employed during the field research stage of this project. It elaborates on the insights that were obtained from the various research methods and then proceeds to explain how these insights were translated into a design intervention, one that created an "action platform". Action Platforms: "These are systems that make various interactions possible, prompting and hindering certain kinds of behaviours while leaving "opportunities for action and interpretation open" (Manzini 2011) (Meroni, Sangiorgi 2011). The section ends by evaluating the merits and limitations of the proposed intervention, discusses the feedback that was obtained from the user testing process, and charts out a future roadmap for the project.

3.4.1 FIELDWORK, METHODOLOGIES AND TOOLS

3.4.1.1 Evaluating position

Before departing to India for fieldwork, I was advised by my thesis supervisor to create a document with three sections and fill each one up with bullet points. The sections were titled 'What do I already know?' 'What do I need to know?' and lastly, 'What tools do I use to obtain this missing information?' This document helped form the basis of the research methodologies and tools that were employed during this project.

Takeaway:
- Mapping the knowledge gaps
- Identifying appropriate tools to use for research

3.4.1.2 Expert Interview

To create a valid base for the study, as a first step, I began with a 1-on-1 expert interview. People who are experts in their particular field are usually a gold-mine of knowledge and this method is often the best to get an unbiased view of any situation without influence from others, except for the moderator (Ireland 2001).

The first of my expert interviews was with water expert S.Vishwanath, who painted an overview of the water scenario in Bangalore city, eventually focussing on the system around the Jakkur Lake. "One of the key challenges for Bangalore in terms of sustainability is water.

We have only one source that is reliable, the Kauveri river and we have a limit to what we can draw from it…if 1400 litres are drawn, about 1100 litres of sewage is created each day. How the city manages this is a big challenge." He said, while talking about the current state of water and sewage in the city.

While explaining the how the systems around the Jakkur Lake function, he stated, "In Jakkur, the treatment plant was set up in 2003. By 2009, due to citizen action, the lake being taken up by the BDA, fenced, de-silted, islands created, bunds created, trees planted and it was serendipity that this happened to be just downstream from the Jakkur sewage plant.

Now, the wastewater treatment plant is functioning and there has to be a lot of pressure to ensure that it functions well…such systems are so dynamic. The system eventually reaches some sort of a balance as it goes through ups and downs at its own rate."

At the end of the interview, when asked about the importance of communication and design interventions, he mentioned "It is essential for (not only the locals) but also the key institutions in the city and the politicians to realise the potential of Jakkur and see whether they can take this model to other lakes. As of now, Jakkur is able to provide enough potable water, for about 100,000 people at 10 million litres per day. So, if one lake is individually providing water for about 1 lakh people, we can only imagine 100 lakes of Bangalore doing the same.

Now, how do we communicate this idea across, as nobody seems to have seen it? Each institution is only seeing its tiny part."

This interview with S.Vishwanath was an eye-opener and provided a great starting point for my contextual studies. I was well equipped with enough basic data to visit the site.

Takeaway:

- The biggest problem Bangalore city had in terms of sustainability was water management.
- The current system in Jakkur could was a model for sustainable urban water management but there was a no knowledge exchange about it taking place both within the involved actors as well as other citizens.

3.4.1.3 Observation and Site visits

Throughout the project timeline, at least one visit to the lake every week was scheduled. Each visit had a different purpose – some to observe or walk around the lake while others to interview stakeholders, sketch or create photo essays.

The huge expanse of water tucked away from the main highway had a big visual impact. My first visit to the lake was the first time I was able to visualise all that I had been researching about. A mental note about the visual experience of the space was made, and this highly informed the final intervention as well. The first visit was primarily for observation. Here is an excerpt from one of the blog entries, describing the first visit.

"I finally managed to visit the Jakkur lake, a week after I arrived here in Bangalore with Lena, a Swiss student who is studying the quality of water in the Jakkur lake and its effects on people's health. We were told that the activities of the fishermen would be at its peak at around 6.30 or 7 am. We made sure we reached there at around 6.25 am. About 15 km from the city centre, this lake is one of the few lakes that remain in the north eastern part of the city and has a lot of history attached to it due to its proximity to Yelahanka, the place where the Kempagowda (founder of Bangalore) dynasty hails from. The lake itself is man-made, is over 200 years old and was initially built to store rainwater.

Early in the morning, the weather was perfect and I got thrown aback when we walked past the dusty roads and the fence that has been built during the lake rejuvenation project to protect the lake. It was a huge expanse of water, a 50-acre lake with a capacity of about 40 million liters of water. It looked beautiful with a number of birds including the very recognisable pelican, gracefully swimming in the water. The huge construction site on the western side of the lake was the only visual evidence that reminded me that we were still in Bangalore city. We decided to start walking from the southern tip, where the outflow of the lake could be seen - as shown in the picture above. There was a small shrine where the fenced area ended and the outflow began."

(Blog post titled 'The first visit to the lake", posted on the 30TH of November. www.jakkurlake.jux.com)

Takeaway:

- The lake showcased a great potential in transforming into an exhibition or experiential space
- The visual impact of the location had much more impact than reading or hearing about it, even if the information was credible.

3.4.1.4 Citizen Action Forum – Save the Lakes of Bangalore

I had the opportunity to attend a one-day intensive workshop that was organised by the Citizen Action Forum (CAF) Bangalore titled, 'Save the Lakes of Bangalore.' This was a forum where various activists and citizen action groups that were working to rejuvenate, maintain or improve conditions around the lakes of Bangalore city, spoke about their journeys. As mentioned earlier, these citizen action groups are very active in Bangalore city and have a great leverage when it comes to taking cases to the higher authorities for action. This particular forum brought together the most well known bird watchers, biologists, historians, activists and some decision makers of Bangalore city. The lake activists shared stories about their struggle to involve the government and other citizens to develop their lake area. They wanted the lakes to be a source of fresh water for the city, while also performing other functions like providing a space with fresh air, a space that citizens could use for evening walks or watch birds in. "It was a great boost to our morale when we saw the government body cleaning and fencing the lake after we had started the campaign to save the lake. It told us that our voices were being heard and taken seriously." Said an ecstatic Usha Rajagopalan, a 'Lake Champion' of the Puttanhalli Lake. The speakers also brought up issues regarding the involvement of civic bodies and the government, and how the various involved organisations need to communicate with each other in order to move projects forward.

This workshop ended with all the participants making a list of recommendations about various topics, which would later be taken up at the policy-making level. The group I was part of, had to make a list of methods and tools that could be employed to gather all the basic data related to a particular lake.

This workshop helped me network with experts working within this field and collect information about the lakes of Bangalore. It also informed me about how the full potential of these lakes was still not being acknowledged. A larger vision for an urban lake, like what was happening in Jakkur, was not being recognised or discussed.

Takeaway:

- There was a lot of support both from the government as well as the citizens within the domain of lake activism and rejuvenation
- In order to create impact on a large scale, any new ideas had to be well articulated and involve the CAF, the citizens as well as the decision makers.

3.4.1.5 Visual-Storytelling using photo essays

"A picture is worth a thousand words" is a universally well-known phrase, emphasising the amount of data that one image can carry and convey when compared to words or textual data. Organising and creating meaning out of many photographs requires a lot of patience and planning. This is said to be an art that requires key observation skills as well as a good understanding of the subject one is working with (Ireland 2001).

In this project, photo-documentation was used to create photo-essays that built stories around artefacts and people. This can be a tricky method to use with an audience whose responses or actions might vary when a camera is pointed at them. On the other hand, if the subject is open and free, it is a great tool that helps capture mundane activities as well as the intricacies in actions and behaviour. Two photo-essays were created as part of this project. The first one titled, 'A day in a life of a fisherman', gives a glimpse of the process of fishing and the effort that goes into this process. The second one takes the viewers on a journey through the STP, showcasing the various treatment processes as well as stories of people who live and work in the plant. The process of trying to capture these moments helped me notice and understand various processes: the difficulties the fishermen go through, their relationship with the lake and water, the small, yet functional vegetable garden that an employee had created using sludge from the STP as fertiliser, as well as the beauty of the lake and its surroundings. This was a good method to collect stories from around the lake as it also functioned as a good conversation starter. Cameras and photographs often intrigue both children and adults alike. This method highly informed the final walk-through as well. The walk is designed to be as 'experience-based' as possible, involving the various stakeholders and artefacts around the lake, while using the "users as a resource" (Manzini 2011). Often, users are profiled as "active in proposing but passive in action." (Manzini 2011) while when a user is being considered as a resource within an action platform, this makes way for endless opportunities and makes the solution more open ended (Manzini 2011).

Takeaway:

- This activity encouraged me to observe and document smaller functioning processes and activities around the lake and create visual narratives out of them, i.e. how the fishermen obtain, clean and sell the fish, how the steps of the big open well is a cosy place to sit down and read, how the various treatment processes within the treatment plant take place etc.

3.4.1.6 Open interviews with stakeholders

"Individual interviews are ideal for learning exactly how each person feels and thinks about a topic or design…" (Ireland 2001). During this study, a series of one-on-one interviews and discussions were conducted with the various actors involved with the Jakkur Lake. The insights from these interviews formed the backbone of the final design intervention. These interviews were peepholes to look into how each interviewee perceived their role and their relationship with the lake – the one entity that connected them all.

VENKATESH | FISHERMAN

"Just like we use the lake, even they do. People come and wash clothes, they have a bath sometimes. Who are we to say anything to them? We have no rights."

Venkatesh, a fisherman who has been fishing in this lake for the past 15 years lives in a small hut right next to the lake. He is very interested and keen in talking to people who pass by. Many villagers wash their clothes and utensils using detergent that would affect the fish in the lake. When asked what his views on this were, he said, "I am aware of that. Just like we use the lake, even they do. People come and wash clothes, they have a bath sometimes. Who are we to say anything to them? We have no rights. Yes the water gets dirty, but we can't go control such activities. They just happen." His matter-of-fact attitude showed that he was aware of some of the activities talking place around the lake, but it was not in his power to do anything about it. He also felt that the other citizens deserved an equal chance to make use of the water body for their livelihood, just like he did. Next, he was asked to comment on what people knew about the water quality and how this ecosystem functioned. His reply was, "Some people who live around the lake know that this water comes from the STP. Everyone in the surrounding villages trusts that the water is good. That's why they come to buy fish from us. There have never been complaints of people falling sick until now, so the water must be good!"

SURESH | CHEMIST

"There is always an information gap. Everyone knows about some part of the system, but not how the entire thing functions."

A short walk up north from the fishermen's dock is where Suresh, the chemist who worked at the sewage treatment plant made his rounds. Every day, Suresh spent most of his time at the STP. He had a good grasp of all the happenings around the lake. "People use the water from the lake for cleaning and bathing and they drink from the open wells. The groundwater flows into the open wells and they use it for drinking and cooking. The fishermen fish in the lake and sometimes people come for a walk or jog around the lake" he said.

The questionnaire that he was given, had questions about the technical processes involved in the plant, the origins of the wastewater and how it was tested and treated. There were also questions about the various stakeholders who play a role in the sustenance of this system and the kinds of interactions he has with these stakeholders. Since he worked at the plant, he had to interact with government officials who usually visited to do a quality control check. When asked if the BBMP or BWSSB conduct any programmes or awareness campaigns to inform people about this system, he said, "The civic bodies are always conducting some programmes or the other, but the people do not know what they are about or what it is meant for. There is always an information gap. Everyone knows about some part of the system, but not how the entire thing functions." He admitted that most employees of the plant were in a similar situation. They do their job well, i.e. to make sure that the quality of water coming into and going out of the plant meet the set standards. Interactions between the community around the lake and the people who work within the STP was minimal, he mentioned. "Sometimes they come to us with some problems - like if there is an outflow problem, if the pipes are clogged etc. Other than this, there is no real interaction." He only knows about some of the happenings around the lake as he likes to go on walks and test samples from the bore wells near the lake to see if the water quality has changed after the wetland and ground filtration processes.

KOSAVAMMA | LABOURER

"I do not know where this water comes from but we drink the water from this well as our rent is inclusive of this. We do not filter it before drinking"

A short walk down south from the STP is where the storm water drain has been built. This area is where women usually come to wash their clothes and utensils, as the platform of the drain works well as a flat surface to sit on, while washing. Ramya, a young lady who uses the lake to wash her family's clothes almost three times a week was spotted there and she said that she came there only to wash clothes. When asked why, she answered, "There is no constant supply of water in my house. We get water once in 3-4 days and we store it in drums for all other domestic purposes. This is the closest place to wash clothes. We cannot use it for any other purposes because the 'toilet water' comes into the lake. This is the main reason we use it only for clothes." From this, it was clear that she did not know about what was happening at the STP or of the quality control of the water that is done frequently. In a discussion around what she knew about the STP and whether she felt that they were polluting the water by using detergent, she said, "Some people know about the STP but the water in this lake is not clean! There is a board that says, "Do not litter the lake" but no one follows any instructions. The water is polluted with 'toilet water' from the nearby buildings and thus is not fit for any other use. So, we are doing no harm by washing our clothes here."

Kosavamma, a construction labourer who lives in the informal settlement near the lake was the last interviewee. About 25 families including hers, drink water from the open well that is fed by the Jakkur Lake and is situated in their housing area. "I do not know where this water comes from but we drink the water from this well as our rent is inclusive of this. We do not filter it before drinking", she said as she was drawing water from the well. "No one has fallen sick so the water must be good enough to drink." This statement was enlightening in more than one way. It could be seen that raw sewage actually transformed into potable water that is consumed without filtering and it also spoke volumes about how unaware these communities were with regard to the water sources they depend on as well as the happenings in their environment.

Takeaway:
These interviews were very essential to the process as they painted various perspectives of the same picture. Each respondent had his or her own view on the lake, its functions and the water quality. While the STP employees were observed to meticulously test the water every hour to make sure that it met the regulatory standards, the ladies who came to wash were convinced that this lake was just like any other in the city, polluted by sewage from the neighbourhood. Along with these views, each one had an interesting story to tell or a perspective to share that would really help people understand the system holistically, if they only they had access to this information.

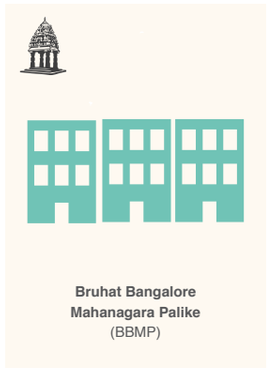
It was also very evident that each individual was in their own 'bubble' and there was no interaction or communication between the various respondent and the decision makers rarely featured.

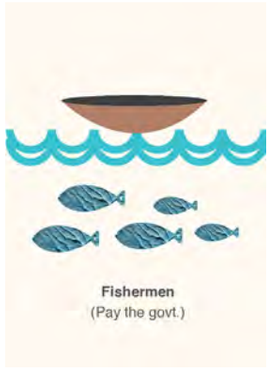
This presented a big need to propose an intervention that would paint the larger picture and encourage interaction both within and outside the system.

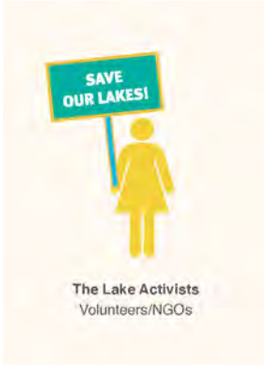
3.4.1.7 Stakeholder mapping

It is important to involve people who are part of the system in order to understand their views both about the problem, as well as the solution. A participatory process that is successful needs to dig deep into the emotions, hidden values, relationships and attitudes of the participants (Siitonen 2013).

I organized a workshop with the workers from the Sewage Treatment plant in order to understand the roles of the various actors with respect to the lake, from the point of view of the participants. 'Stakeholder cards' were designed and used as artifacts to help organize thoughts, direct the conversation and build a system-map. Each card had an illustration of one actor, along with the organization they belong to. There were some empty cards, incase the participants wanted to add to the list. The objective of the map was to identify map out how these identified stakeholders they interacted with each other as well as the how the participants perceived the influence the actors had on each other and the lake. The participants debated amongst themselves to organize the cards in the order of influence that a particular actor had on the lake – highest to lowest. They then drew a plus sign next to what they felt were positive influences, and a minus sign next to the negative ones. There were lines drawn to showcase the linkages between each of the actors.







> ***Top:*** *Having a conversation about the map that the STP employees had created*
> ***Bottom:*** *The final stakeholder map that was created during this workshop*
> ***Right:*** *The stakeholder Cards that were designed to be used as probes during the workshop*

The activity itself and the discussion that followed were very rewarding. Issues around the relationships between actors surfaced and a fruitful discussion on the power each stakeholder had, took place. Since these were relatively sensitive topics, obtaining such information might have been otherwise challenging. "The BDA, the lake developers have the most positive influence and then the fishermen. The Sewage Treatment Plant and us would be third." Sunil and Prashant, the employees of the STP argued amongst themselves about the order of some of the cards but eventually reached a consensus. "We often remain in our own bubble." Said Sunil, drawing a small circle and writing STP inside it. "We do our work. We make sure that the water quality is as per standards when it exists the plant. We have no idea what happens after that. It would be good to have some interaction and communication".

"I feel that the villagers who use the lake for domestic purposes have the most negative influence." Said Prashant. " They pollute the lake and are unaware of the quality of water that it contains."

Takeaway:
Although the views were subjective, it was essential to understand the viewpoint of each part of the puzzle, before designing something that would affect the entire system.

- It was reiterated that a big communication gap existed and that the various actors were only aware of their individual tasks and roles
- Knowledge and information was not passed on from one actor to the other, creating a multitude of attitudes, opinions and views around the same issues and entities.

3.4.1.8 Walks around the lake

Walks around different parts of the lake aided in observing, photographing, sketching or having conversations with people who passed-by. Content for both the map and the podcasts were informed by these visits and interactions.

"Today I will show you the garden I have made, madam!" Said Sunil, walking into a vegetable patch he had created at the back of the STP, watering it with the treated water and using the sludge from the treatment process as manure.

Some of the sludge (waste) from the treatment plant is used as fertiliser to grow a small vegetable garden at the back of the sewage treatment plant. Sunil, one of the employees who has a flare for gardening, maintains the garden. The vegetables that are grown are cooked and eaten by the employees of the plant.

The ingenious idea of using small pieces cut-up banana stems to shade the newly planted saplings is Sunil's. As seen in this photograph, he explained to us that he had seen some of the farmers from his hometown use this technique to prevent young plants from dying due to excess exposure to the sun.

3.5 INSIGHTS

3.5.1 Awareness, Communication and Systems Thinking

As discussed in the above section, research conducted during the case study clearly presented the need for awareness, communication and involvement of all the actors including the citizens and the decision makers. As discussed earlier, the leverage and impact that each stakeholder's actions might have will vary, but as systems thinking theory suggests, each action does affect other parts of the system, and this eventually adds up. When it comes to dealing with real-world wicked problems, as both Conklin and Checkland suggest, analysing and studying the problem using tools like dialogue and discussion to arrive at a common understanding or "formulating a root definition" (Checkland 1981) of the problem is the first step towards proposing any valuable solution.

3.5.2 Ownership and involvement

Bringing out the embedded and enriching knowledge and stories within the system

There was a clear lack of interest and ownership in some of the actors around the lake. As discussed earlier in this study, this could be due to ignorance, lack of a better solution or lack of power and initiative to create change. Some of the actors like the domestic users were helpless, and had no choice but to use the lake the way they were, but if increasing ownership could be a by-product of the proposed intervention, it could encourage better adoption and usage of the same resources. Involving the locals not only utilises "scientific expert knowledge" which is the mundane top-down approach, but also takes into account what the locals have to offer, switching it to a "bottom-up" approach (Smith 2008). The users could also be treated as resources, (Meroni, Sangiorgi 2011) enabling knowledge sharing at various levels, leading to better adoption and involvement.

3.5.3 Experiencing and learning from the physical space

Sights, interactions and conversations in person

The impact that experiencing the physical space had, lingered in my mind throughout the process. Reading about the lake was drastically different from visiting it, looking at the various flora and fauna, artefacts, processes as well as interacting with people who had exciting stories to share. The aim of the final intervention was to re-create this experience to the largest extent possible so that the audience could experience the interconnectedness of this system.

3.5.4 The role of a designer in this process

At this juncture, it is essential to step back and examine what the role of a designer is, within such a space. In a world where there are clashes in interests, power distribution and viewpoints, it is difficult for people who are part of the system to have an objective view about it. Organisations and communities attached to the system might find it difficult to look beyond their interests and goals. Understanding the entire system or identifying opportunities for betterment or change is something that is not a natural process in such situations. Therefore, a possible solution might be to introduce a third party who is neutral, and can examine, understand and map out the entire system. A designer is in a good position to play this role by encouraging exchange between interrelated stakeholders. New methods or tools could be developed to aid this process and this should be more than a "standardised product design outcome". There must be more emphasis on positive interaction between stakeholders rather than the designer's success. Such strategies are likely to fit under the term design activism (Hirscher 2013) . Design Activism is defined by Fuad-Luke as "design thinking, imagination and practice applied knowingly or unknowingly to create a counter narrative aimed at generating and balancing positive social, institutional, environmental and/or economic change". As mentioned earlier, he defines a design activist as a "non-aligned social broker and catalyst; a facilitator; an author; a creator; a co-author; and a happener (someone who makes things happen)" (Fuad-Luke 2009) .

In the context of this case, the main tasks were to understand and unearth all the stories and issues and make them available to all the stakeholders, for them to create their own picture. The design challenges were raising awareness, enabling systemic thinking and creating opportunities for communication.

The massive 50 feet ancient open well that is fed by the Jakkur Lake. It proves a 100,000 litres of water to the farmers each day

3.6 IDEA: DESIGNING THE WALK

"The walk aims to talk about how this lake can be a potential model for Integrated Urban Water Management, a possible direction to help Bangalore city's water problems." (Baradwaj 2014)

Keeping the above insights in mind, the final intervention was conceptualised. This involved designing and organising an experiential walk around the lake. The aim of the walk was to inform both the participants and the community around the lake about how this complex system functioned. Dialogue around this particular lake and system also helped the citizens and higher authorities recognise its potential to be used as a model for other lakes in the city.

The design phase involved creating a map of the lake that was engaging and easy to understand, accompanied by an audio podcast that would guide the audience around the lake. This walk was designed for users of all age groups that wanted to learn about, understand or impact the lake in a positive manner—right from interested school students to the lake activists and decision makers.

The decision to create this walk was informed by the insights discussed above – the need to inform the various stakeholders about how the entire system functions, the need to involve the local community and the need for the decision makers to realise that this is a potential model for water sustainability for the city. There is a possibility of the intensity of the 'wickedness' in a wicked problem reducing, if all the involved stakeholders understand their own functions as well as the whole system, creating opportunity for change. Currently, the walk has been designed for this specific lake, but is a template that can be applied to other lakes around the city and country.

3.6.1 The Map

Using information graphics or visuals can help simplify complex data and thus make information more palatable and easy to understand for people who are less educated or not interested (Hirscher 2013) Fuad-Luke states that "Finding new ways to communicate requires imaginative use of design to penetrate beyond the 'white noise' (many random signals of equal intensity) of contemporary life" (Fuad-Luke 2009) The challenge lies in not overloading the users and in making this complex information accessible, and available for them to appropriate based on their own needs and wishes.

The map was the first artefact that was designed for the intervention. It functions as an infographic that brings all the collected data and stories from around the lake onto a single sheet of paper. The map is designed to have a 'quirky feel' to make the large amounts of information both interesting and less intimidating for the audience. The map has a walking trail marked around the lake area for the participants to follow. Along this trail are interesting spots that have been identified and numbered to help the audience discover various aspects and dynamics around the lake. At each of these spots, the participant has the freedom to stop, stand, absorb and/or do an activity i.e. shoot a photograph or have a conversation with a local, depending on where they are. These 'tasks' or 'off-beat interactions' are highlighted on the map and the participant can choose to do it, or not. The aim of this was to create a dialogue between the participants of the walk and the actors around the lake, enabling knowledge sharing, and increasing awareness about the various individual parts of the system, as well as the system as a whole. This is also an interesting way to bring out the small stories that people were happy to share, and as a by-product, the sense of ownership the locals felt towards the lake was affected.

The map contains two levels of information. The first one equips the user with basic facts, the functions and stories about each of the identified spots.

The map of the Jakkur Lake with numbered spots that guide a participant around the lake and help them discover it

The second level contains more technical information that might be specific to disciplines that researchers or other discipline-specific audience or decision makers might be interested in. Examples of these would be the different kinds of bird species that might interest the bird watching community or the chemical composition of the water that is let out from the treatment plant that might interest the pollution control board or water engineers. The trail is designed in such a way that the user has full autonomy to decide which spots they stop at, what kind of information they listen to and share, as well as the tasks they perform. Hence, this makes the learning and sharing a dynamic and unique experience.

3.6.2 The podcast and interface

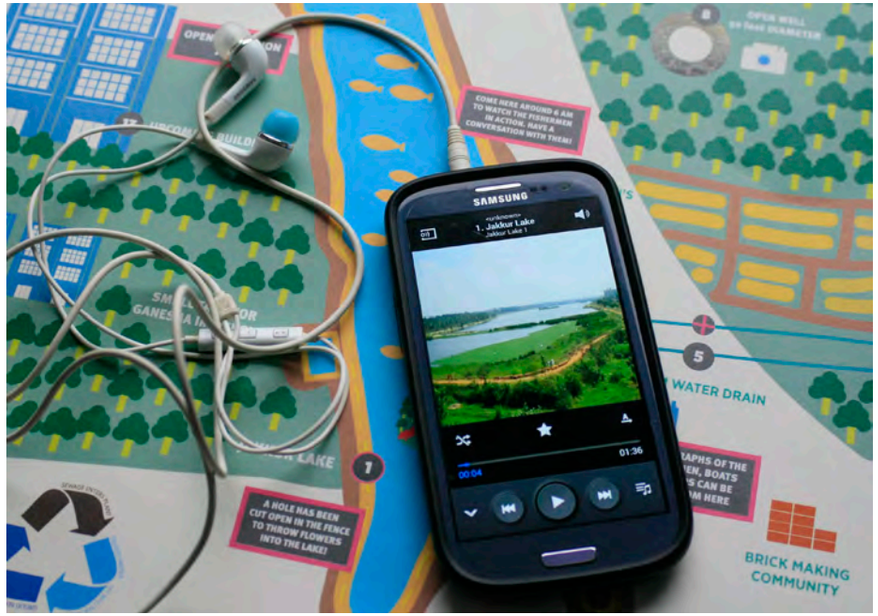
To make the experience as effortless and affordable as possible, without the need of any extra manpower, it is designed to be an audio-guided tour. Each identified spot on the map corresponds to an audio file or podcast that the user can listen to, when they are at that particular spot. If a smart phone, tablet or any device that has the ability to display an image is used, there is a photograph of the location that is displayed along with the audio file, confirming that the participant is at the correct spot. The sound track explains what that place is about, post which, it directs the user to either have a conversation with a local for more information, do a task that would help them learn more about that particular spot or move on, to the next spot.

The second set of audio files are marked with a '+' sign and this is for an audience that is looking for more specific or technical data related to the lake and not just basic information or stories; i.e. the names of the different species of birds or fish that can be found in the lake or the or chemical composition of the water exiting the treatment plant etc.

The content for these podcasts is a collation of data from various sources such as newspaper articles, research papers, blog posts as well as interviews with experts from each particular field. They are simple audio files that can be updated at any point in time if there are any changes in the data.

3.6.3 How can a walk be organised?

Currently, this is a pilot project where all the material needed for the walk is available under the creative commons online, on the project blog (www.jakkurlake.jux.com) for any one to download and use. Participants who are interested in trying out the walk can print a copy of the map and download the audio playlist onto their phones, ipods or ipads and experience the lake



A preview of what the user sees when they choose to listen to the first audio file that introduces the Jakkur Lake to them

by themselves or with their friends and family. Only 12.8 million people out of the 1.2 Billion people in India have access to smartphones (. Smartphone sales in India triples to 12.8 million, says IDC2013) hence, the audio files are of a format that can be played by any feature phone as well. With enough time and funding, a public service could be set up around this. A Bangalore heritage walk organised every weekend for interested citizens. Similarly, a lake information walk series could be incorporated as well.

"I have been looking for something to do with my children over the weekends that help them learn while doing something exciting. This would be just perfect for that!" said Suhel Quader, an evolutionary ecologist from Bangalore.

"If this reaches the BWSSB officials, it would be great for the city. They could take ownership of it and maybe even set up a public service around it." said S.Vishwanath.

3.7 USER TESTING: EXPERIENCES AND FEEDBACK

Once the map and podcasts were available for use, it had to be tested to see how well it functioned. I had the opportunity to take two groups of people on the walk. On the first trip were employees from the Consortium of DEWATS Dissemination (CDD http://www.cddindia.org), a company that works on specialised decentralised sewage systems and on the second day were twenty faculty and students of various age groups from the sustainability department of the Bhoomi College (http://www.bhoomicollege.org), Bangalore.

The first group had time only explore the stretch of the sewage treatment plant while the second group tried the entire walk. During the walk there were both interesting an unexpected actions and conversations that took place. Even though the audio guide was designed for individual use, the students decided to walk around in pairs or small groups, and played the audio file out loud, instead of using earphones or headphones. This automatically became a communal activity where they listened to the podcast together, discussed what they knew and had a set of questions to ask at the end – ones that were not answered, or raised by the podcasts. The students took a break at some spots such as the big well, to absorb and capture its beauty while some had a long conversation with a fisherman who was free to talk after his work, about the water quality and the different kinds of fish he sees in the lake. There was indirect knowledge sharing that took place both between the members themselves as well as the local community. The local community was very interested and intrigued by the audience and were happy to discuss and share their issues and opinions with them. "I am only sharing what I know. That is no trouble. I am happy to take people around the treatment plant and explain how it works." Said Suresh, the chemist who works at the sewage treatment plant. At each spot, the students had questions to ask about the pre-rejuvenation phase and how various processes around the lake functioned, and this generated an interesting discussion amongst all the participants. All these students were studying sustainability and thus, they felt that all this information and the walk would truly inform their future research and designs. A short documentation video of this walk can be found on the project blog.

"IT WOULD BE GREAT IF EVERYBODY CAN ACCESS IT EASILY. MAYBE SOME KIND OF A PUBLIC SERVICE?"

RUPERT MARQUEZ

There were many positive comments as well as ideas on how the idea should be developed in the future. "I like the way the trail was organised." Said one of the students. "This map and podcast would be really helpful in actually understanding what this entire space is about, if we were to even come alone."

Rupert Marquez, a member of faculty from Bhoomi College said that he would really like to see how to build a public service around this and make it accessible to the residents who would eventually move into that particular area. "I don't know how you would do it, but it would be great if everybody can access it easily. Maybe some kind of a public service?"

"It could involve QR codes! People can just walk around with their smart phone, beep it on the spot and listen to information about that particular location" said Jan, a fellow researcher and participant of the walk.

3.8 MERITS, LIMITATIONS AND WAY FORWARD

Testing the designed experience helped collect data on what worked and what did not. This feedback will be incorporated when the project is further developed. Below are two tables: one that lists the merits and the other, the limitations of the solution. Both the tables state the premise within which each statement is based as well as recommendations for a way forward.

Participants walking on the path along the lake and discussing questions that were raised during the walk

LIMITATIONS	PREMISE	STEPS FORWARD
One has to travel to the location and carry the materials (map and podcasts) with them to experience the location. In its current format, people who do not live in Bangalore will not be able to experience it the same way	This is designed to be an experience based walk. Research shows that experiencing and passive reading or listening produce different results and rates of absorption	An online simulation of the lakes could attempt to re-create the physical experience for someone who does not live in Bangalore. Short audio and video files that a user clicks on, to be guided through the space. An aspect of gaming could be introduced as well i.e. a treasure hunt to provide incentive for people to absorb the otherwise educational data.
Currently there is no way for people to access the package if they want to try the walk as there is no service set up around it	In the current stage of the project, there have only been pilot walks that have been organised. The eventual goal would be to set up a self-sustaining service. The project has been written about in the national papers and other online forums and has reached a wide range of people. There have been proposals about developing a 'Lake-Walk' series for Bangalore city. Currently, both the map and the audio files are freely available online for people to download and use at their convenience	Pitching this idea to both the governmental organisations as well as NGOs such as Bangalore Walks. They currently organise the Bangalore Heritage Walks every weekend. A similar 'Lake Series' could be organised for the interested citizens to take part in. Another possible direction could involve setting up a free public service where the Lake Action group, Bangalore Birdwatchers Group or other volunteers could organise weekend walks around the various lakes in the city
This walk relies on the users having access to a smart phone or a smart device	**This package was targeted at the citizen action groups, students, decision makers and interested citizens of Bangalore city most of whom have access to a cell phone and many, to smartphones, but the feature phones were not ignored while designing the walk. The only advantage in using a smartphone is the possibility to view a photograph of the location while listening to the podcast. Using a feature phone does not take away from the experience in big way.**	**Having access to a smartphone and an internet connection opens up many more possibilities such as using QR codes and Google maps, thus making the physical map redundant. These techniques could be adopted at a later stage and the design can be appropriated to include additional features, but to begin with, this was designed to be a low-fi setup, to make it easy and accessible to as many people as possible**
Currently the podcasts are available only in English.	Even though Bangalore city has a large English speaking population, it would be beneficial to have the podcasts available in Kannada (the local language) to make it more accessible as 64% of the locals speak Kannada (Fatihi 2002).	Translating the current content to create audio files in Kannada
The current walk requires participants to carry a physical map during the walk	If the participants have access to a smartphone, the trail could be organised using a GPS based map that would guide them around the lake, while QR codes could be used to link them to the audio files	This is one way of designing a new service or application that will help people navigate purely using a smartphone

MERITS	PREMISE	STEPS FORWARD
Scalability	When the project was written about in the newspapers, it reached other lake activists and volunteers who shared interest in organising similar walks for other lakes around the city	To scale this up and host a series of 'Lake Walks' that would help create a dialogue around water management in the city
Requires basic infrastructure	Keeping in mind the variety and demographic of the audience this package has to cater to, it is essential that only basic skills be required to use it. Currently, if one knows how to read a map and operate sound files on a mobile phone, they will be able to participate in the tour	Keeping the infrastructure requirement at a basic level is beneficial as it can be used both by the young and the elder generations alike. Over time, a smartphone with an internet connection could replace the paper map, and the same device could serve both as the map as well as the audio guide
Can be used both individually as well as in groups	The system is designed for an individual to walk around the lake with their earphones while stopping to look around, have conversations etc. This could also turn into a group activity, as was seen during the user testing activity, where pairs or groups of people listened to the podcast together. This created a more dynamic atmosphere and encouraged discussions and questioning	Allowing the system to be flexible makes the users appropriate it to their convenience, thus creating way for interesting experiences and results
Can be integrated into the school curriculum or developed as a series of walks for the citizens of Bangalore.	**Faculty from Malya Aditi International School and Prakriya Green School showed interest in taking their students on the walk to talk about waste water management and urban ecology.**	**There are many possible extensions and ways to appropriate this educational material and it can be done so, as the material is currently available online under the creative commons license**

Young boys returning to the fisherman's dock with their catch for the day (from the Jakkur Lake)

DISCUSSION AND CONCLUSIONS

4.1 CONCLUDING REMARKS

"Every wicked problem is essentially unique" (Horst, Melvin 1973)

Drawing from the above statement, this body of work explores one such unique wicked problem in the realm of sustainability — a complex urban water management system where there is no common understanding of the system between the multiple stakeholders who are involved with it. Theory suggests that this is a problem that is often encountered in systems that involve multiple stakeholders, and that various strategies could be applied and tested to address the same. The strategy one chooses to apply would depend on the kind of situation being dealt with, the number of stakeholders involved, the power they have to affect the system as well as the resources available to the problem solver – in this case, the designer. The theoretical chapter of this thesis explores various strategies that have been written about, but the final proposition is that 'understanding and taming' would be the first steps to begin working with any wicked problem. Philippe Vandenbroeck, a bio-engineer and systems thinker talks about three ways to deal with complexity in his TED talk titled 'Working with Wicked Problems'. According to him, the three elements that are needed to deal with wicked problems are design, systems thinking and dialogue, and the intervention proposed in this study examines characteristics of the same. Vandenbroeck talks about how systems thinking is "thinking about the big picture, thinking dynamics (understanding behaviour over time) and working with boundary judgments" and tools like dialogue that "exercise empathy and build social capital" and design, that leads to "solution oriented working and imagining- developing visual representations of what might be" aid in understanding these complex systems (Vandenbroeck 2013).

The experiential walk around the Jakkur Lake uses fundamental ideas such as awareness and involvement to create an understanding that might help the stakeholders maintain the existing system, while also positioning it as a potential model for sustainable urban water management at the city level. The walk itself allows people to experience the space through stories, and learn from what they see, hear and share. Tools such as the map and podcasts that are given to the audience assist them in exploring and discovering this space. As a by-product, conversing with the locals and learning from each other creates a two-way information sharing space. One might argue that being aware of something does not necessarily lead to any constructive change within the system, and this has to be accepted. As discussed earlier, a lot of the change making is dependant on the power and inclination that the stakeholders possess to create any change. This stage can only be reached when there is a common understanding of how the system functions, as well as the roles and responsibilities of the involved members.

In the case of the Jakkur Lake, it was essential for all the actors such as the fishermen, STP employees, people who use the lake for domestic purposes etc. to be aware and involved to help maintain this system, but a large-scale impact can only occur when this information reaches decision makers such as the BWSSB or BDA, and they decide to get involved. This would be the stage at which other lakes in Bangalore city might be playing a role similar to what the Jakkur Lake does currently. The Citizen Action forums also have potential to mobilise this kind of action. This is in no way to suggest that the people who live and work around the lake cannot create any change. On the contrary, unless these individuals and communities are aware of their own roles as well as the roles of others around the lake, the current system would malfunction, and this is exactly what the walk is trying to prevent.

This proposed experiential walk tests the role that design can play in breaking down complex systems and making this information accessible and easy to digest and share, while encouraging interpersonal interaction. As Alastair Fuad-Luke states, the designer plays the role of a "design activist" in this case, "a non-aligned social broker and catalyst" who "uses their skills and knowledge to improve and change a current situation for the social and/or environmental better." (Fuad-Luke 2009). The format of the proposed solution is open and easily replicable, allowing it to be appropriated to other contexts, ensuring its scalability. Areas for future research could involve developing the current material, and moving to the next step to examine how to mobilise interested and informed stakeholders to create a positive change within the system.

4.2 PUBLISHED MATERIAL AND OUTREACH

After the test walks were organised, a Bangalore focused, citizen-oriented news magazine covering city public affairs, community and culture named 'Citizen Matters' published an article that I had written about the project (http://bangalore.citizenmatters.in/articles/en-route-to-a-water-sensitive-city-the-story-of-jakkur-lake). This gave the project some visibility and triggered conversation around lakes, water systems and sewage within the interested communities. Due to this, I also received emails from various lake activists, organizations and volunteers, asking if collaboration to create similar material for some of the other lakes around the city would be possible – reinforcing the scalability of the solution, and creating a future roadmap for the project. Subsequently, the project was also written about in one of the most reputed

national newspapers called 'The Hindu' by the water expert of Bangalore, S.Vishwanath. The article was titled 'Water and the art of communication' and is available as an electronic version at http://www.thehindu.com/features/homes-and-gardens/water-and-the-art-of-communication/article5689688.ece. All the positive feedback from the participants and the enthusiastic responses from the citizens and organisations who had heard about the project was a great source of encouragement to plan a way forward. Possible avenues that would help scale the project up have also been discussed – making a Bangalore 'Lake Walk' series in collaboration with 'Bangalore Heritage Walks', developing icons so that volunteers can create their own maps for their neighbourhood lakes and conduct similar walks, involving interested stakeholders as guides or mentors for these walks i.e. Suresh from the STP in the case of Jakkur Lake, was more than happy to show people around and share his knowledge with them. This particular proposal could even involve some remuneration and an economic model can be built around these walks, if a sustainable public service were to be set up. At the moment, the small goal of enabling a discussion around this particular model of water management has taken a step forward. Accurately measuring the success of such qualitative data is a difficult task but the responses and feedback have been largely encouraging and avenues to take it to the higher authorities are being explored.

4.3 EVALUATION OF RESEARCH QUESTIONS

There were three research questions that this study attempted to explore. The questions were built around understanding how a designer could break down wicked problems or complex systems, which often involve multiple stakeholders, and propose strategies that would help communicate a common understanding of the system, and how this links to sustainability. This becomes highly challenging and interesting as every wicked problem, as the theory states, is unique. Throughout the design process, I tried to evaluate how the findings and ideas answered these questions. Parts of the insights have been shared and discussed in the process chapter of the study, but each question will be individually reflected upon here.

1. In complex systems involving multiple stakeholders, how can a designer enable common understanding and awareness?

The famous scientist Jane Goodall said, "Only if we understand, can we care. Only if we care, we will help. Only if we help, we shall be saved" (Srikantaiah 2014).

Both the literature as well as the case study, made me think about the idea of

'understanding' complex systems. Systems theory talks about how it is not enough to study the smaller parts of the system to impact the whole, while researchers who have worked with wicked problems talk about 'taming' a problem in order to understand and address it. Before any dramatic solution that will affect the system can be proposed, it is important for the researchers as well as the involved stakeholders to really understand what the system entails. What is it about? How are they currently linked to it? How they can affect it in the future? The nature of such systems are complex, and being a part of such a system only makes it difficult to be unbiased, deconstruct and understand the various linkages within the system. This is often why people are satisfied performing their own roles, not knowing how else they could impact the system for the better. As Fuad-Luke explains, reaching a common "problem definition" (Horst, Melvin 1973) with such complex systems is itself subjective as it originates from a stakeholder's point of view and "Therefore all stakeholders' points of view are equally knowledgeable (or unknowledgeable) whether they are experts, designers or other actors" (Fuad-Luke 2009) . Thus, even if a problem definition is agreed upon, or a common understanding created, we have to keep in mind that it might not be a very accurate or a neutral one, but it is definitely the best possible first step to take, without which no proposed ideas would function or be accepted. There would be no dialogue and no common agreement on how to frame the problem, goals or actions (Fuad-Luke 2009) .

As a designer, my role was to be a neutral third party to understand and deconstruct the system and its parts, and make this information available to the various involved stakeholders. I realized that the first step in creating any kind of awareness or change is in the understanding of the various issues and actions that occur within and around the system, even if it were to be interpreted using ones own knowledge and perspectives. I tried to achieve this by using narratives and interesting visualization to make the collected information easy ad exciting to understand. The information was also left customizable, enabling the audience to choose the information they wanted to access. Philippe Vandenbroeck, a bio-engineer and systems thinker talks about design being one of the three ways to deal with complexity. He claims that design leads to "solution oriented working, abductive thinking, imagining and developing visual representations of what might be" (Vandenbroeck 2013) . Drawing from this statement, I could expand upon how a designer can enable awareness and understanding.

When dealing with such complex systems, often the power to affect it does not lie in individual hands. The higher authorities or decision makers need to be involved to create any measurable change, but to begin this process, we need a charged and informed community, possibly with their activist hats on.

How does this group get created? As discussed earlier, the views of someone within the system will be biased by their own roles, interests and actions and thus, this calls for a third party to formulate what this system is about. The importance of having this third party or a "design activist" (Fuad-Luke 2009) can be clearly justified if the example of the Jakkur Lake is considered. It is a system where there is a lack of communication and understanding amongst the involved stakeholders themselves, and only someone outside the system can address this. This is the role a designer plays. How the designer decides to unearth the stories, deconstruct the system and present this information is the design challenge.

In this study, I used various design and ethnographic tools to understand the merits, challenges and viewpoints around the system. I collected stories, opinions, suggestions and information of all kinds and represented part of this data in an audio-visual format where the audience has full autonomy to choose what they take back or share. If the data was not directly available to the audience, there were cues as to how one could obtain this missing information, i.e. by talking to a local or looking up a website. Hence, even though I processed this information, I attempted to make it as neutral and true to reality as possible. This created a lot of dialogue and dynamism while the content was being shared and pondered upon, by the participants of the walk.

2. Does more user/stakeholder involvement mean better awareness of the system and its impacts?

After dealing with the first question that looks at a birds-eye view, now we zoom in, to look at the individual parts of what creates the whole. While researching this case, as discussed in the section titled 'process', the interviews informed me that involvement is not directly proportional to awareness. For example, if we were to consider the ladies who used the lake for domestic purposes, their relationship with the lake was a close one. They interacted with this water body almost every day, yet their understanding of its nature and contribution was tainted by the patterns they had seen in the other lakes of the city. They were convinced that it was contaminated and thus, felt no guilt it adding to the contamination. It could also be concluded that they did not have much choice but to wash in the lake, but the civic bodies could do something about this smaller issue. The gap in communication between these women and the other actors including the informed citizens of Bangalore, led to them forming their own opinions that were not necessarily true. Hence, it is important to bring out these various perspectives and discuss them in order to form a consensus about a how a system functions, and the kind of impact it can have. The right kind of involvement is needed to affect the system positively and this of course, is not an individual task. It is the same case with the fishermen too. They were well aware of their task and very involved in the process of fishing in the lake, yet they paid no heed to the women using detergent to wash up, even though this affected the fish in the lake. Thus, it is not only about being involved or invested in ones own actions and priorities but to be well aware of what is happening systemically. Even this does not necessarily create change as discussed earlier, but at least encourages the stakeholders to think about where or what kind of impact they would like to create. How this awareness transforms into real action is highly dependent on the kind of motives and leverage that each stakeholder has and this is an area of research that still needs to be explored.

3. Can understanding of roles, ownership and involvement be a catalyst towards sustainability?

This question zooms back out to look at sustainability in the long run. Whether being aware or having access to more information leads to chance in action can only be determined by conducting a longitudinal research study over a larger period of time. Hence, data from this single case study cannot do full justice in answering this particular question, but a small example from the case can be discussed as a possible move towards it.

Over the two and half month research period, there were frequent visits to the Sewage Treatment Plant. As this treatment plant was being spoken about as a novel idea, there were more visitors who were interested in studying the model as well as looking at how this closed-loop system worked. The actual treatment capacity of the plant is 10 MLD but during the start of the research, only about 4 MLD was being treated and let out into the lake. The two months of constant visitors, interest from the citizens as well as the discussions that took place saw a tremendous increase in the amount of water that was being treated. The records that the treatment plant maintains shows an increase of 4 million liters over the past 3 months, hopefully eventually reaching its maximum capacity to treat 10 million litres each day.

Thus, we can see signs better functioning within the system, but this question is much deeper, and provides a possibility for future research. To answer this question, one needs to work with the same stakeholders to study a particular system over time to see how the information provided to them transforms into actions and involvement and if this necessarily transforms the system into a sustainable one. The term sustainability itself suggests long-term. Both qualitative and quantitative data would be required to 'measure' the sustainability quotient of the system. As concluded in the previous question,

it is not enough to understand ones own role. It is essential for all the stakeholders to be invested in creating a common understanding of everyone's roles and responsibilities, post which, collective action towards sustainability can be taken using the various methodologies proposed in the theory.

4.4 FUTURE PROSPECTS

This project and walk is only a pilot, to help kick-start a dialogue about lakes and water bodies in Bangalore city. This particular idea aims to be a template for all the other lakes and water bodies in the city and country. The walk itself has not been set up as an official public service yet and thus, currently one of the biggest limitations is the access to the material. "How will people know about this?" asked Rupert, a faculty from Bhoomi College who attended the pilot walk as a participant. Even though the blog attracts a fair number of people due its online presence and the publicity received, there is still a long way to go before it reaches a larger audience base. The eventual goal would be to collaborate with a civic body or an NGO to set up a public service around these walks. There has already been interest shown in creating similar packages for some of the other lakes in Bangalore city and I plan to continue and volunteer to make maps and podcasts for the lake activist groups who are interested in using this as a tool for their activism.

As discussed in the section 'Merits, limitations and recommendations for way forward', creating a virtual experience of the walk, where instead of interacting with the local community, people would watch videos of the same, would be a way to make this information accessible to a larger audience base. One need not travel to a location to understand it. Though both online and offline experiences have their own advantages and disadvantages, it is always good to make it available and let the audience choose which medium they would like to use. At the current stage of the project though, its down-to-earth feel helped the participants accept the map and podcast very quickly. Some of the participants had difficulties with the podcast even with such minimal use of technology and thus, it would be better to make it more technology-dependant only as time goes by and people have access and are more informed about using smart devices.

Awareness and participation are going to remain important aspects of any social system. The role of a designer in exploring such complex systems and how this acts as a catalyst for sustainability is a much larger question that can be explored in the future research. I aim to continue creating these packages for the other lakes in Bangalore city and share ideas to encourage urban water sustainability. More about the project and its progress can be found at www.jakkurlake.jux.com.

This is a step well that is over a 100 years old. It has a 50 meter diameter and is on the eastern side of the lake. About 100,000 litters of water is pumped up from this well every day. These kinds of wells are a part of our cultural heritage and are not built anymore. Thus, there is a big need for us to talk about them and preserve them. The scale and grandeur of this lake is something that strikes a visitor within seconds of looking at it. The clear green water adds to its magnificence. Currently this well is also fed by the lake. It would go dry very soon otherwise.

BIBLIOGRAPHY

Census of India. 2011.

Anonymous 2011, 'Rainwater harvesting Bill passed in Assembly'. The Hindu, Bangalore, January 14.

BARNOSKY, A.D., HADLY, E.A., BASCOMPTE, J., BERLOW, E.L., BROWN, J.H., FORTELIUS, M., GETZ, W.M., HARTE, J., HASTINGS, A., MARQUET, P.A., MARTINEZ, N.D., MOOERS, A., ROOPNARINE, P., VERMEIJ, G., WILLIAMS, J.W., GILLESPIE, R., KITZES, J., MARSHALL, C., MATZKE, N., MINDELL, D.P., REVILLA, E. and SMITH, A.B., 2012. Approaching a state shift in Earth's biosphere. Nature, 486, pp. 52-58.

BHUSHAN, G., GUPTA, N. and LEE FUQUA, J., 2013. JOURNEYS FOR WATER: Survival Strategies in Urban India. India: Frog Design, pp. 7-11.

BROWN, R., KEATH, N. and WONG, T., 2008. Transitioning to Water Sensitive Cities: Historical, Current and Future Transition States. 11th International Conference on Urban Drainage, Edinburgh, UK, pp. 1-4.

CHECKLAND, P., 1981. Systems Thinking, Systems Practice.

CONKLIN, J., 2010. Wicked Problems and Social Complexity. Cog Nexus Institute, pp. 1-11.

FATIHI, A.R., 2002. 'Urdu in Karnataka'. Language in India (2), December 9.

FUAD-LUKE, A., 2009. Design Activism. U.S.A: Earthscan, Preface and pp. 25-145.

HASSELL, T., 2007. Promoting Behavioural Change in Household Water Consumption: Literature Review. Victoria: Smart Water, pp. 1.2-2.3.

HIRSCHER, A., 2013. Joyful participation in new ways of designing and making clothes, Enabling person-product attachment to potentially reduce unnecessary consumption, Aalto University School of Arts, Design and Architecture, p.43.

HORST, J.R. and MELVIN, M.W., 1973. Dilemmas in a General Theory of Planning. Policy Sciences 4, 4.

HOWE, C.A., BUTTERWORTH, J., SMOUT, I.K., DUFFY, A.M. and VAIRAVAMOORTHY, K., 2011. Sustainable Water Management in the City of the Future.

HOYER, J., DICKHAUT, W., KRONAWITTER, L. and WEBER, B., 2006. Water Sensitive Urban Design : Principles and Inspiration for Sustainable Stormwater Management in the City of the Future, Manual. Hamburg, Germany.

IRELAND, C., 2001. Qualitative Methods: From boring to brilliant. In: B. LAUREL, ed, Design Research, Methods and Perspectives. Massachusetts: The MIT Press, pp. 23-29.

JENTOFT, S. and CHUENPAGDEE, R., 2009. Fisheries and coastal governance as a wicked problem. Marine Policy, 33(4), pp. 553-560.

MASON, R. and MITROFF, I., 2010. Complexity: The nature of real world problems. In: B. DE WIT and R. MEYER, eds, Strategy: Process, content, context : An international perspective. 4th edn. United Kingdom, pp. 27-33

MEADOWS, D., MEADOWS, D., RANDERS, J. and BEHRENS, W., 1972. The Limits to Growth: A Report to the The Club of Rome, pp. 1-9.

MERONI, A. and SANGIORGI, D., 2011. Design for Services. England: Grower Publishing Limited, pp. 1-6.

OSTROM, E., JANSSEN, M.A. and ANDERIES, J.M., 2007. Going beyond Panaceas, 2007, National Academy of Sciences.

PRYSHLAKIVSKY, J. and SEARCY, C., 2013. Sustainable Development as a Wicked Problem. In: SAMUEL F. KOVACIC, ANDRES SOUSA-POZA, ed, Managing and Engineering in Complex Situations. Canada, pp. 109-119.

RAYNER, S., 2006. Wicked Problems: Clumsy Solutions – diagnoses and prescriptions for environmental ills, July 2006.

ROBERTS, N., 2000. Wicked Problems and Network Approaches to Resolution. International Public Management Review, 1(1).

ROCKSTRÖM, J., WILL, S., KEVIN, N., ÅSA, P., F STUART, C., ERIC, L., LENTON, T., SCHEFFER, M., FOLKE, C., SCHELLNHUBER, H.J., NYKVIST, B., A. DE WIT, C., HUGHES, T., VAN DER LEEUW, S., RODHE, H., SÖRLIN, S., SNYDER, P.K., COSTANZA, R., SVEDIN, U., FALKENMARK, M., KARLBERG, L., CORELL, R.W., FABRY, V.J., HANSEN, J., WALKER, B., LIVERMAN, D., RICHARDSON, K., CRUTZEN, P. and FOLEY, J., 2009. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Ecology and Society, 14 (2)(32).

SENGE, P., 1990. The Fifth Discipline: The art & practice of the learning organization.

SHANKAR, V., KULKARNI, H. and KRISHNAN, S., 2011. India's Groundwater Challenge and the Way Forward. Economic & Political Weekly, No. 2 (VOL XLVI).

SHANKARAN, S., LEIGH, E. and KRUSE, P., 2008. Using Systems Thinking to Explore Wicked Problems. ALAR Journal, 14(2).

SIITONEN, P., 2013. Participatory methods and facilitation skills course material. Aalto University, Helsinki, Finland.

SMITH, J., 2008. A critical appreciation of the "bottom up" approach to sustainable water management: embracing complexity rather than desirability. Local Environment, 13(4).

SRIKANTAIAH, V., 2014, 'Water and the art of communication'. The Hindu, Bangalore, February 14, 2014.

SRIKANTAIAH, V., 2013. 'For a water-sensitive city'. The Hindu, Bangalore, August 10, 2013.

SRIKANTAIAH, V., 2013, 'There is no such thing as waste-water'. The Hindu Habitat (Bangalore), November 15, 2013.

SRIKANTAIAH, V., 2013. Water and Bangalore. Bangalore. Interviewed by Aajwanthi Baradwaj [in person] Bangalore, 25.09.2013. Email the interviewer at [aajwanthi@gmail.com] for the full transcript of the interview.

WHYTE, K. and THOMPSON, P., 2011. Ideas for How to Take Wicked Problems Seriously.

WYRWOLL, P., 2012. India's groundwater crisis. Australian National University, Australia: Global Water Forum.

ONLINE REFERENCES

Anonymous 2013. Smartphone sales in India triples to 12.8 million, says IDC. Live Mint & The Wall Street Journal. Viewed on March 4, 2014. Available at: http://www.livemint.com/Industry/53wbGwhSCE5SoRwGYsIiIL/Smartphone-sales-in-India-triples-to-128-million-says-IDC.html.

Sustainability explained through animation, 2010. Real Eyes Video. Viewed on March 20, 2014. Available at: http://www.youtube.com/watch?v=B5NiTN0chj0.

BARADWAJ, A., 2014. Towards a water-sensitive city: The story of Jakkur Lake. Citizen Matters. Viewed on March 16,2014. Available at: http://bangalore.citizenmatters.in/articles/en-route-to-a-water-sensitive-city-the-story-of-jakkur-lake.

BASU, S., 2013. Bengaluru water utility to launch door-to-door drive to check illegal borewells. Down to Earth. Viewed on November 20, 2013. Available at: http://www.downtoearth.org.in/content/bengaluru-water-utility-launch-door-door-drive-check-illegal-borewells.

DESAI, P., 2013. Jakkur Lake: a potential model for urban water sustainability Viewed on February 26, 2014. Available at: http://thealternative.in/environment/jakkur-lake-a-potential-model-for-urban-water-sustainability/. The Alternative.

FISCHER, J., 2012. Be holistic if you study real-world problems! (But how?!). Viewed on March 16, 2014. Available from: http://ideas4sustainability.wordpress.com/2012/11/15/be-holistic-if-you-study-real-world-problems-but-how/.

MCPHEARSON, T., 2013. Wicked Problems, Social-ecological Systems, and the Utility of Systems Thinking. Viewed on March 16, 2014. Available at: http://sustainablecitiescollective.com/nature-cities/113741/wicked-problems-social-ecological-systems-and-utility-systems-thinking. New York City: Sustainable Cities Collective.

MEDIA ACTION TRUST, B., 2013-last update, Climate Asia [Homepage of BBC], Viewed on December 26, 2013. Available at: http://www.bbc.co.uk/mediaaction/climateasiadataportal/explore/india.

NEILL, C.J., 2007. Systems Thinking. U.S.A: Penn State Great Valley School of Graduate Professional Studies. Viewed on March 5, 2014. Available at: http://www.personal.psu.edu/cjn6/Personal/Systems.pdf.

PEEVEE and LAKSHMANAN, S., 2013-last update, Bangalore Lake Diaries [Homepage of Korkai]. Viewed on February 15, 2014. Available at: http://bangalorelakediaries.com.

SHARMA, N., 2013. Water Shortage Crisis Looms Large In Bangalore, India Viewed on November 6, 2013. Available at: http://globalvoicesonline.org/2013/07/26/water-shortage-crisis-looms-large-in-bangalore-india/. Bangalore, India: Global Voices.

SRIKANTAIAH, V., 2013. The commodity that is water. Viewed on March 16,2014. Available at: http://rainwaterharvesting.wordpress.com/2013/02/23/the-commodity-that-is-water/

SRIKANTAIAH, V., 2012. A new role for water bodies in the city – Bangalore Viewed on September 2, 2013. Available at: rainwaterharvesting.wordpress.com.

SRIKANTAIAH, V., 2012. Water literacy – Closing the loop in a lake near Bangalore. Viewed on September 26, 2013. Available at: http://rainwaterharvesting.wordpress.com/2012/05/19/water-literacy-closing-the-loop-in-a-lake-near-bangalore-2/, Bangalore.

VEALE, J., 2013. What is Systems-thinking?. Viewed on February 18, 2014. Available at: http://futurecultures.blogspot.fi/p/systems-design.html edn. Future Cultures.

WORLD WATER COUNCIL, World Water Council. Viewed on February 18, 2014. Available at: http://www.worldwatercouncil.org/library/archives/water-crisis/.

ZALASIEWICZ, J., WILLIAMS, M., SMITH, A., BARRY, T.L., COE, A.L. and BOWN, P.R., 2008. Are we now living in the Anthropocene? GSA Today, Viewed on May 5, 2014. Available at: http://www.geosociety.org/gsatoday/archive/18/2/pdf/i1052-5173-18-2-4.pdf.

Fish icon used in the book created by Patrick Morrison from The Noun Project under Creative Commons Attribution, Viewed on March 5, 2014, Available at: http://thenounproject.com.

GLOSSARY

- **BDA:** Bangalore Development Authority - a governmental organization and the principal planning authority for Bangalore. Its function, under the Karnataka Town and Country Planning Act of 1961 (KTCPA), is as a regulatory body required "to prepare in the prescribed manner a Comprehensive Development Plan"

- **BWSSB:** Bangalore Water and Sewerage Board - premier governmental agency responsible for sewage disposal and water supply to the Indian city of Bangalore

- **IUWM:** Integrated Urban Water Management - the practice of managing
freshwater, wastewater, and storm water as components of a basin-wide management plan.

- **LPCD:** Litres per Capita per Day

- **MLD:** Million Litres per Day

- **STP:** Sewage Treatment Plant

APPENDIX

7.1 TRANSCRIBED INTERVIEWS

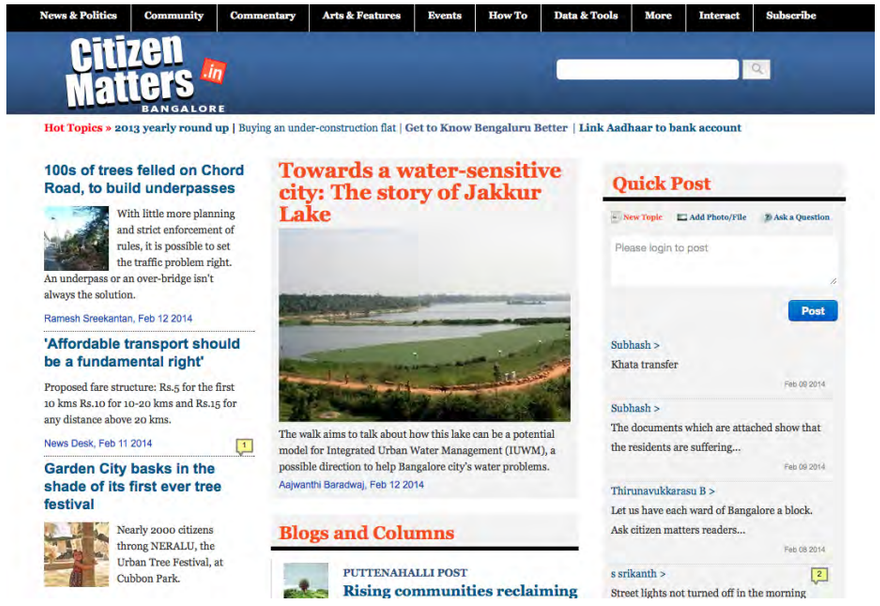
1. Interview with Vishwanath Srikanthaiah, water expert from BIOME Environmental – a Bangalore-based firm focused on ecology, architecture and water conducted in person by Aajwanthi Baradwaj on 25.09.2013
For a full transcript of this interview, please email the author at: aajwanthi@gmail.com

2. All the other interviews conducted during this study i.e. with Girish: the Chemist at the STP, Sunil: the engineer at the STP, Venkatesh: the fisherman, Ramya: the young lady who uses the lake for domestic purposes and Kosavamma: the construction worker, are available on the project blog – Towards a water sensitive city: The story of Jakkur Lake.
https://jakkurlake.jux.com

7.2 PUBLISHED MATERIAL

A Bangalore focused, citizen-oriented news magazine, covering city public affairs, community and culture named 'Citizen Matters' published an article that I had written about the project, on their forum. The article can be found at: http://bangalore.citizenmatters.in/articles/en-route-to-a-water-sensitive-city-the-story-of-jakkur-lake

Subsequently, the project was also written about by S.Vishwanath, in one of the most reputed national newspapers – 'The Hindu'. The article was titled 'Water and the art of communication' and is available as an electronic version at http://www.thehindu.com/features/homes-and-gardens/water-and-the-art-of-communication/article5689688.ece



Top: Article on the project published in Cittizen Matters
Bottom: The project written about in The Hindu

Right: *A map of the Jakkur Lake designed to aid the walk, as part of the project. It functions as an infographic that brings all the collected data and stories from around the lake onto a single sheet of paper.*


A!
Aalto University
School of Arts, Design
and Architecture